An Efficient Way of Increasing Capacity of Hybrid Wireless Mesh Networks with Random APs

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Abstract**—** *In conventional Wireless Mesh Networks (WMN) is the backbone of interconnected Mesh Routers (MRs). In this paper hybrid WMN architecture that is able to utilize random connections to Access Points (APs) of Wireless Local Area Network (WLAN). In this architecture, capacity enhancement can be achieved by advantage of the wired connections through APs. In addition related to the number of MR cells as a conventional WMN, the analytical results expose that the asymptotic capacity of a hybrid WMN is also powerfully affected by the number of cells having AP connections, the ratio of access link bandwidth to strength of link bandwidth, etc. Suitable configuration of the network can severely improve the network capacity in this network architecture. It also shows that the passage balance among the MRs with AP access is very important to have a tighter asymptotic capacity bound. The results and conclusions give good reason for the outlook of having such a hybrid WMN utilizing widely deployed WLANs.*

Keywords**— *Access points, asymptotic capacity, WLAN, wireless mesh networks, mesh routers***

I. INTRODUCTION

1.1 Introduction to Wireless Mesh Networks

Wireless Mesh Networks (WMNs) have become a practical wireless solution for providing community broadband Internet access services. These networks show uniqueness that is novel in the wireless environment, and in many ways more similar to conventional wired networks. In Infrastructure WMNs, Access Points (APs) provide internet access to Mesh Clients (MCs) by forwarding aggregated traffic to Mesh Routers (MRs), identified as relays, in a multi-hop manner awaiting a Mesh Gateway (MG) is reached. MGs proceed as bridges between the wireless infrastructure and the Internet. In multicast group multicast routing protocols delivers data from source to multiple destinations. Several protocols are proposed to provide multicast services for multi-hop wireless networks. The capacity of such an ad hoc network with infrastructure has been seen.

Although there has been extensive work on using high throughput metrics to improve the performance of wireless networks, work. Previous work primarily focused on high throughput by using Adaptive Dynamic Channel allocation and Interference and congestion Aware Routing Protocol. Protected wireless multicast was less studied, and existing work focused primarily on identifying the attackers. In this work Channel Aware Detection Mechanism is planned to identify the attackers and thus given that better performance.

1.2 Structure of Wireless Mesh Network

Fig 1.1 shows a typical WMN infrastructure. In such networks, it is potential to provide each infrastructure node with multiple radios, and each radio is able to access multiple orthogonal channels, referred as Multi-Radio Multi- Channel transmissions. The mesh clients are frequently laptops, cell phones and other wireless devices while the mesh routers ahead the traffic to and from the gateways which may but need not connect to the internet. The coverage area sometimes called a mesh cloud.

WMNs can provide large coverage area, lower costs of backhaul relations, enlarge end-user battery life, and more importantly provide no Line Of Sight (LOS) connectivity among users not including direct LOS links. Recent commercial and academic deployments of WMNs in real world are beginning to demonstrate some of these advantages. However, a number of challenges continue so that a WMN performance in terms of throughput and delays match the performance of a wired network.

A wireless mesh network is a special type of wireless ad-hoc network. A WMN often has more planned design, and may be deployed to provide active and cost successful connectivity over a certain geographic area. An ad-hoc network is formed when wireless devices come within communication range of each other. The mesh routers may be movable, and be moved according to precise demands arising in the network. Repeatedly the mesh routers are not inadequate in terms of wealth compared to other nodes in the network.

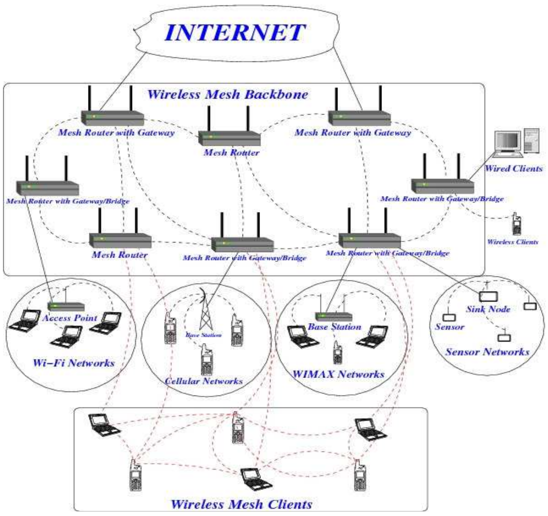

Fig1.1 Infrastructure of Wireless Mesh Networks

1.3 Security in Mesh Networks

The Conventional WLAN security mechanism provide standardized method for authentication, access control any encryption between a wireless client and an access point. Since more wide area mesh solutions store to retain compatibility with commercial off-the-shelf WLAN client adapters, existing consistent WPA2 mechanisms are commonly retained. However, there are many different types of wireless mesh architectures, where each of that are used a different approach for wireless security.

Wireless Mesh Network (WMN) is emerging as a promising technology in providing ubiquitous high-speed service for Mobile Clients (MCs), also called mesh clients. Mesh routers (MRs) play a necessary function in a WMN, which provides repair for MCs on one hand; forward data packets via wireless link to adjacent MRs on the other hand. Interrelated MRs form the strength of character to WMN, where several special MRs connecting to the Internet with wired cables are called Internet Gateways (IGWs). By taking advantage of wireless multihop forwarding [2], deployment of MRs poses much less constraints as they can be deployed on electric poles or house rooftop. Such deployment enables a WMN to provide low cost metro-scale reporting for MCs' access.

The major challenge in a WMN is the capacity degradation problem caused by the interference on a single or multiple routing paths during multihop broadcast. Even though the network architecture of any WMN is different from an ad hoc network, the asymptotic capacity bound resulting by the analytical work in is still valid for a WMN backbone [3]. Per MR capacity of a randomly deployed backbone with ad hoc routing can be given by

$$\Theta\left(\frac{W}{\sqrt{N_R \log N_R}}\right) \text{ ------------- (1.1)}$$

Where W denotes the maximum backbone link data transmission rate between a pair of neighboring MRs and NR denotes the number of MRs. It is obvious that the size of the network is largely constrained by requirements of per-MR capacity. By optimizing the locations of MRs, per-MR capacity can be improved by a factor of $\varphi(\sqrt{\log N_R})$ Actually, MRs need not have access to A/C power as energy can be supplied from self-equipped solar panels. MRs can even be "dropped" anywhere required. Then, per-MR asymptotic capacity can be said to approach $\varphi(W/\sqrt{N_R})$. By deploying IGWs in the network, the whole WMN forms multiple clusters where each cluster is led by an IGW and constraints MRs. Readers interested in various cluster construction methods are suggested [4]. After IGW clusters are formed, the traffic between the MRs in different clusters, i.e., intercluster traffic, are directed to their associated IGWs and utilize the wired connections between the IGWs. Similar network architecture is the hybrid ad hoc networks, where infrastructures are inter-connected with wired cables and deliver data packets for ad hoc clients in a single or multiple hops. The capacity of such an ad hoc network with infrastructure has been investigated Due to random deployment connectivity has a major impact on the performance. Two geometrically close by MCs may have a very long routing path due to weak network connectivity. Recent results indicate that per-MC capacity under strong connectivity can achieve $\varphi(W'/\log N_R)$ where NC denotes the number of MCs and W' denotes the total bandwidth. Bandwidth W' is shared by all MCs for ad hoc connection or the connection to infrastructure with time division multiple access (TDMA) scheduling. It is noted that MRs, MCs, and IGWs share the same spectrum with TDMA scheduling [8], which are different from a common two-tier WMN. The role played by MR in is more like a relay that has additional forwarding function to MC. It has been pointed out in [9] that current IEEE 802.11 MAC protocol cannot achieve a reasonable throughput as the number of hops increases to four or higher. A two-tier WMN illustrated employs dedicated spectrum for the backbone and different spectrum for access link between MR and MC. MCs can use IEEE 802.11, which has been widely adopted for Wireless Local Area Network (WLAN) connection. As different notations used for backbone links and access links, MRs can have two types of wireless interfaces and use multichannel multi radio [10], [11] for backbone connections.

Second, deploying multiple APs in a large coverage area leads to serious inter-WLAN interference and throughput degradation [2], [12]. In addition, the Medium Access Control (MAC) layer of APs cannot support handover for MCs. Although many APs can be deployed, it is still not feasible to provide seamless coverage in a city by APs without huge investment on cables and it is not efficient for APs to provide service directly to MCs. The use of APs in WMN needs to be explored.

A higher capacity bound for a WMN with three-tier hybrid network architecture by exploring random AP connections, where MR is allowed to connect to the APs in its coverage. The proposed network architecture is illustrated. Backbone links use a dedicated spectrum with bandwidth W bps. MRs and IGWs employ multiple orthogonal channels to isolate interference regions. Each MR is equipped with multiple radios that are able to operate on different channels simultaneously.

The impact on capacity from APs is related to the deployment. MRs and IGWs are pre-deployed by Internet Service Provider (ISP) at planned locations for constructing a WMN backbone. In contrast, APs are randomly deployed by users and the connection between AP and MR is random. APs could be turned off by the users and new APs could appear to be active.

The network coverage can also be enhanced as MRs has good outdoor coverage while APs have better indoor coverage. Knowing that WLANs and WMNs are different networks, our scheme provides cooperation between WMN and WLANs by utilizing the residual capacity of WLANs. The focus of different environment enables two types of networks to work together. This three-tier WMN achieves capacity enhancement at near no additional cost as WLANs are already deployed. It is compatible with current wireless network technology and facilitates current MCs to explore that.

II. EXISTING SYSTEM

The whole network information at the MRs may lead to excessive overhead and may not facilitate easy management of the clustering approach. The capacity degradation problem caused by the interference on a single or multiple routing paths during multi hop transmission. Even though the network architecture of any WMN is different from an ad hoc network, the asymptotic capacity bound resulting by the logical work is still valid for a WMN backbone. MRs poses much less constraints as they can be deployed on electric poles or house rooftop. Such deployment achievability enables a WMN to provide low cost metro-scale coverage for MCs' access. The whole WMN forms multiple clusters where each cluster is led by an IGW and constraints MRs closer to the IGW. Readers attracted in various cluster creation methods. After IGW clusters are formed, the traffic between the MRs in different clusters, i.e., inter-cluster traffic, are directed to their associated IGWs and utilize the wired connections between the IGWs. Access Points (APs) limited coverage can only support relatively small region, like area within a house or an office. Extending the coverage by multiple co-deployed APs requires availability of wired cables at the AP locations.

III. MAIN CONTRIBUTIONS

- Proposing novel network architecture a hybrid WMN, this will have a higher capacity than a conventional WMN. Presence of APs in the exploitation area of conventional WMNs is supposed and access links for the connections to MRs are used. Thus, from the network design view, existing WMN is complete with new elements APs and a new link type AP-MR link, and translates a two-tier system into a three-tier system.
- Applying analytical model to the proposed network architecture;
- Deriving an asymptotic capacity value for MRs and MCs under various conditions.

IV. PROPOSED SYSTEM

4.1 Traffic Model

Traffic generated or terminated at MCs can be divided into inter-cluster and intra-cluster traffic. The inter-cluster traffic is from the MCs to the destination outside the cluster or from the source outside the cluster to the MC in the cluster. The traffic in IGW is in-charge of aggregating, inter-cluster traffic, routing in the wired network, protocol discussion.

4.2 Routing and Traffic Balance

The edges between intersection points denote the communication links. Packets can send out from one MR to the neighboring MR in the grid, which counts as one-hop transmission. The location of MRs in the grid can be expressed by two integers: an integer for the x-axis and the other one for the y-axis.

4.3 Intra-cluster AP Traffic

The intra-cluster traffic between two MCs in the same cluster, it can also utilize random connections between MRs and APs. Decreasing the number of hops for the traffic going to the Internet reduces the load in the backbone. The enhancement is mainly affected by the number of accessible APs and the bandwidth of such random connections.

4.4 Inter-cluster AP Traffic

With random access to APs, the capacity is increased by leveraging the AP's wired connections. For some gateway functions such as authentication and authorization located in the cluster head (IGW), AP still can forward the traffic to the IGW by the wired connections for management purpose.

4.5 The backbone network

- The ad hoc MANET-type traffic which exists in the backbone only among MRs.
- The second one is the random intra-cluster AP traffic. With wireless connection between MR and AP, intra-cluster traffic can utilize the wired connection between two APs.
- The third is the inter-cluster traffic relayed by MRs through the IGW. And the fourth one is the random inter-cluster AP traffic, which uses the wired connection between the AP and the IGW.

4.6 Per-MR Capacity

The backbone network can be divided into four categories according to the types of devices involved. The first type is the ad hoc MANET-type traffic which exists in the backbone only among MRs. The second one is the random intra-cluster AP traffic. With wireless connection between MR and AP, intra-cluster traffic can utilize the wired connection between two APs. The third is the inter-cluster traffic relayed by MRs through the IGW. And the fourth one is the random inter-cluster AP traffic, which uses the wired connection between the AP and the IGW

4.7 Routing and Traffic Balance

The routing and traffic balance scheme used in analyzing a WMN, we use a 2D grid-based WMN. The connectivity graphs of the MRs are denoted by dots at the intersections. The edges between intersection points denote the communication links. Packets can send out from one MR to the adjacent MR in the grid.

4.8 Backbone Ad Hoc Routing

The backbone capacity of intra-cluster traffic with ad hoc routing, i.e., MR to MR traffic, has higher asymptotic capacity with a regular grid deployment. Proposition 1 provides the asymptotic capacity of MRs with grid deployment.

4.9 Intra-cluster AP Traffic

The intra-cluster traffic between two MCs in the same cluster, it can also utilize random connections between MRs and APs. Decreasing the number of hops for the traffic going to the Internet reduces the load in the backbone. The enhancement is mainly affected by the number of accessible APs and the bandwidth of such random connections.

4.10 Inter-cluster Traffic through IGW

Assuming that inter-cluster traffic only transmits in the backbone toward or from the IGW, the per-MR capacity is bounded by the bandwidth of the IGW.

4.11 Inter-cluster AP Traffic

With random access to APs, the capacity is increased by leveraging the AP's wired connections. For some gateway functions such as authentication and authorization located in the cluster head (IGW), AP still can forward the traffic to the IGW by the wired connections for management purpose. Such mechanism can effectively reduce the number of hops and the volume of the traffic in WMN backbone.

4.12 Per-MC Capacity with MR Ad Hoc Routing

The bounds for the number of MCs in a cell with different orders of the number of MRs, which is lead to different per-MC asymptotic capacity in later propositions. Lemma 10 is the critical transmission for MCs in a unit square. It serves as the bound distance between any two MCs in the region.

4.13 Per-MC Capacity with Intra-cluster AP Traffic

A random AP connection, the ratio of the backbone link bandwidth to the access link bandwidth is very serious. The traffic via the APs employs the access link. While it is not adequate, the benefits from using the random connections will be restricted. Raise in the number of AP-MRs can assist to increase the traffic through the APs. The competence of implementing a large number of APs depends very much on the strategies of traffic load balancing. Our traffic balance is based on MCs rather than MR cells. The traffic from the same MR cell may go to different AP-MRs by considering the traffic load on the AP-MRs.

V. HARDWARE SPECIFICATION

PROCESSOR	: PENTIUM IV 2.8MHz
RAM	: 256 MB SD RAM
MONITOR	: 15" COLOR

HARD DISK	: 40 GB
FLOPPY DRIVE	: 1.44 MB
CDDRIVE	: LG 52X DVD RAM
KEYBOARD	: STANDARD 102 KEYS
MOUSE	: 3 BUTTONS

VI. SOFTWARE SPECIFICATION

OPERATING SYSTEM	: RED HAT LINUX
SCRIPTING LANGUAGE	: NS2.34
PROTOCOL DEVELOPED	: C++

VII. RESULTS AND DISCUSSION

7.1. Input Design

Parameters	Value
Total No of Nodes	54
Transmission Range	150 m
Packet Size	512 Bytes
Mac Type	IEEE 802.11
Routing Protocol	AODV
Traffic Model	CBR
Initial Energy	100 J/Battery
Sleeping Power	0.01 W
Transmitting Power	1.5 W
Receiving Power	1.5 W
Idle Power	1.02 W
Area	1000x1000M^2
Queue	Priority Queue

7.2. Simulation Result

Query Latency

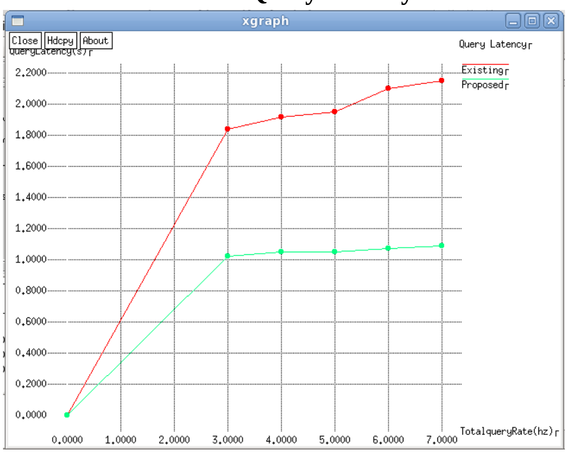

Fig 7.1 represents the comparison ofexisting and proposed query latency

Energy Consumption

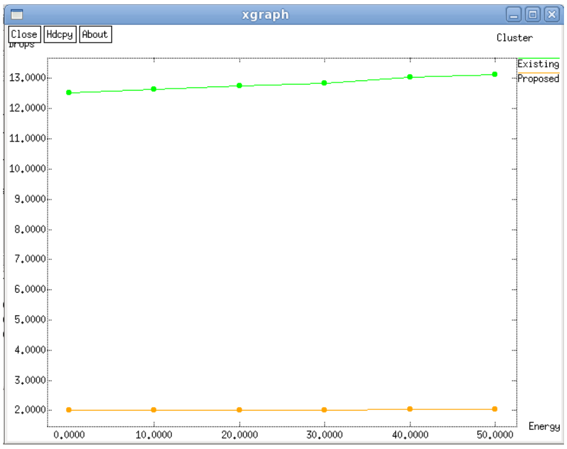

Fig 7.2 represents the comparison of existing and proposed energy consumption

Backbone Comparison

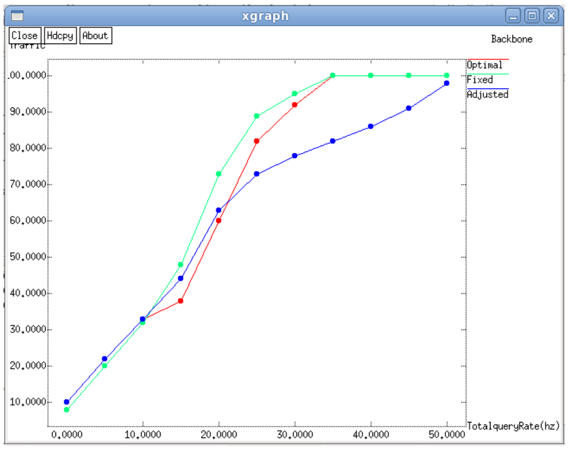

Fig 7.3 represents the backbone comparison of existing and proposed system.

VIII. CONCLUSION

This paper concludes that derived asymptotic capacity of hybrid WMN design with random connections to APs. The access link bandwidth very much affects the capacity, which is dissimilar from a usual WMN. To some point, the ratio of access link to backbone link bandwidth is serious. It increase the capacity bottleneck and magnify the power of AP-MRs. The results show that the capacity improvement by access APs within the exposure of MRs is important which amplify the

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number of AP-MRs and the bandwidth ratio. The development is at the very low cost by using currently existing networks and it is also feasible for those networks to take benefit of a WMN. It is noted that the access to the APs are random, it may have depressing impact on WLANs' presentation when the WLANs' traffics are serious. The future work will be controlling traffic among MRs and WLANs.

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