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Enhancement Throughput of Unplanned Wireless Mesh Networks Deployment Using Partitioning Hierarchical Cluster (PHC)

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Abstract**—**Wireless mesh networks based on IEEE 802.11 technology are a scalable and efficient solution for next generation wireless networking to provide wide-area wideband internet access to a significant number of users. The deployment of these wireless mesh networks may be within different authorities and without any planning, they are potentially overlapped partially or completely in the same service area. The aim of the proposed model is design a new model to Enhancement Throughput of Unplanned Wireless Mesh Networks Deployment Using Partitioning Hierarchical Cluster (PHC), the unplanned deployment of WMNs are determinates there performance. We use throughput optimization approach to model the unplanned WMNs deployment problem based on partitioning hierarchical cluster (PHC) based architecture, in this paper the researcher used bridge node by allowing interworking traffic between these WMNs as solution for performance degradation.

Keywords**—**Wireless Mesh Networks, 802.11s Internetworking, partitioning Hierarchical Cluste.

I. INTRODUCTION

WIRELESS mesh networking has emerged as a promising design paradigm for next generation wireless networks. Wireless mesh networks (WMNs) consist of mesh clients and mesh routers, where the mesh routers form a wireless infrastructure/backbone and interwork with the wired networks to provide multihop wireless Internet connectivity to the mesh clients. Wireless mesh networking has emerged as one of the most promising concept for self-organizing and auto-configurable wireless networking to provide adaptive and flexible wireless Internet connectivity to mobile users. This concept can be used for different wireless access technologies such as IEEE 802.11, 802.15, 802.16-based wireless local area network (WLAN), wireless personalarea network (WPAN), and wireless metropolitan area network (WMAN) technologies, respectively. Potential application scenarios for wireless mesh networks include backhaul support for cellular networks, home networks, enterprise networks, community networks, and intelligent transport system networks.Wireless local area networks (WLANs) are used to serve mobile users access to the fixed network within broadband network connectivity with the network coverage [1]. The WLAN deployments, clients are associated with wireless access points that are interconnected by a wired backbone network combined with the low cost of IEEE 802.11-based hardware led to a success of wireless networking technology. Thus, the wireless network has only a single-hop of the path and the Clients need to be within a single-hop to make connectivity with wireless access point. Therefore to install network can achieve wide area coverage a large number of fixed access points need to be deployed with the many wiring network needs for the backbone. As result a Deployment of large-scale WLANs are very cost and time taking. However, The WMNs can provide wireless network coverage of large areas without depending on a wired backbone or dedicated access points [1][2]. Wireless mesh networks (WMNs) are improved the next generation of the wireless networks that to provide best services. WMNs are expected to resolve the limitations and to improve the performance of wireless local area networks (WLANs), ad hoc networks, and wireless metropolitan area networks (WMANs)[2]. The wireless Internet access is mainly provided either by cellular networks like GSM, or by networks based on WiMAX or wireless LAN like 802.11, all these technologies are expensive, city-wide Internet access, cellular networks cover large areas, but are expensive, wireless LANs are inexpensive but their communication range is very limited. WMNs are integrating multi-hop communication with internet and expected to provide internet connectivity everywhere to a large number of users for several services, the WMNs are dynamically self-configured, with the nodes in the network automatically establishing and maintaining mesh connectivity among themselves in an ad hoc fashion, typically implemented at the network layer through the use of ad hoc routing protocols when routing path was broken or blocked. This feature brings many advantages to WMNs such as low cost, easy network maintenance, more reliable service coverage.

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Wireless mesh network component (e.g., access points, desktops with wireless network interface cards (NICs), laptops, Pocket PCs, cell phones, etc.) can connected to each other via multiple hops. In the full mesh topology, each node (mesh router or other device) is connected directly to each others [3],

One or multiple mesh routers that are connected to the Internet can then serve as gateways and provide Internet connectivity for the entire mesh network. In the partial mesh topology, some nodes are connected to all the others. The wireless gateway/bridge functions in mesh routers enable the integration of WMNs with various existing wireless networks such as the Internet, cellular, IEEE 802.11, wireless sensor, Wi-Fi, WiMAX, etc., this integration can be provided the users with impossible services of these networks, the WMN is believed to be a key enabling technology for the fourth generation (4G) wireless systems [3].

In WMNs, nodes are involved of mesh routers and mesh clients, where mesh routers have minimal mobility and form the backbone of WMNs. They provide network access for mesh and clients, each node operates not only as a host but also as a router, forwarding packets from node to another node that may be not direct transmission to the destinations. Mesh clients can be either stationary or mobile, and can form a client mesh network among themselves and with mesh routers [3][4]. WMN is a promising wireless technology for numerous applications, e.g., broadband home networking, community and neighborhood networks, enterprise networking, building automation, etc. It is a very flexible, expandable, scalable, and at the same time robust, resilient and Being present everywhere. In addition, wireless mesh network is easy and fast to deploy for any type of building [5].

II. Motivation

In WMNs the coverage area can easily scalability be increased by simply deploying additional mesh routers. However, this results an increased average path length and it has been shown that the throughput of a WMN degrades rapidly with the number of hops involved in the path [Morris 2001]. Limits in the WMNs scalability is one of the main problems like interference channels will leading to collisions then reduced throughput [7] . With the capability of self-organization and self configuration, WMNs can be deployed incrementally, one node at a time, as required. The reliability and connectivity for the users increase accordingly. Deploying a WMN is not difficult, because all the required components are already available in the form of ad hoc network routing protocols, IEEE 802.11 MAC protocol, while the low cost infrastructure, It is difficult to determine exactly how many users can be supported by a WMN, since this depends on a variety of parameters such as network topology, piece of ground, and type of applications. From that fact WMNs may be deployed with the multi authorities without any planning randomly, as a result many access points deployed randomly in the same service area belonging to different authority and network domains they will be overlapping either partially or completely in the service area [7].

The problem of resource nods congestion due to unplanned deployment also more wireless mesh networks were deployed independent, and the challenging with the multi-hop wireless networks because the networks behavior depends on complicated interaction between many factors such as node interference, traffic flows [6][7].

The capacity of the multiple wireless mesh networks in the same area may be not efficient due to wireless congestion and contention i.e. link congestion with the too much traffic on the link, RF interference problem among neighboring nods with multiple simultaneous transmissions, therefore the WMNs performance in the service area degrading and capacity reduction. Most of researcher achievement design of wireless mesh networks is capacity planning [7].

There are multiple design goals for which a network can be optimized, that need to be able to design routing algorithm, channel assignment and scheduling packets [6]. At the network layer, the most important is the design of new routing metrics that can provide high performance and network scalability as far as routing optimization in an unplanned WMN, i.e., a WMN with an arbitrary topology [4][5][6].

III. 802.11s Interworking

The IEEE 802.11 ESS Mesh Networking Task Group (Task Group s) aims to define a framework for 802.11 ESS mesh networking, in particular the architecture and protocol for self-configuring paths between 802.11 APs over multi-hop topologies .In 802.11s, a WLAN Mesh typically consists of two or more Mesh Points interconnected via IEEE 802.11 links, and within or without Mesh Portals. The Mesh Point is an entity with the 802.11 NIC, and the Mesh Portal is an entity at which MSDUs other world exit and enter a WLAN Mesh to and from other parts of a DS (distribution system) or non-802.11 network. The Mesh Point can be considered as the playing the role of the mesh router (access point), whereas the Mesh Portal can be considered as playing the role of the gateway other word (Multiple WLAN meshes can also be connected by the MPP)[8] as shown in the Fig. 1.

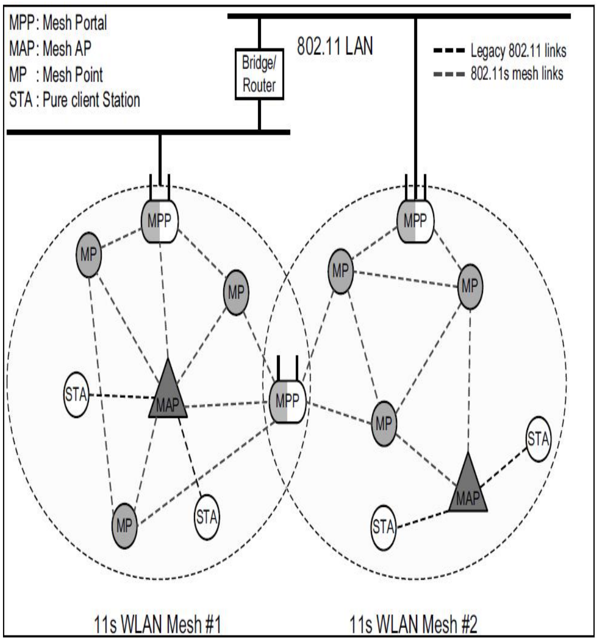


Fig. 1 The Network Architecture for the IEEE 802.11s WLAN Mesh Network

IV. System Model

We consider wireless mesh networks based on the IEEE 802.11a/b/g technology, where individual mesh routers may be equipped with one or more multi channel multi radios based on 802.11a, 802.11b, 802.11g, thereof. Each multi-channel, multi-rate operations as specified in the IEEE 802.11 standards, wireless mesh networks deployed by different authorities may overlap partially or even completely in the same service area, however the author in [1] focus only on the scenario where there is only one unplanned wireless mesh network based on the IEEE 802.11b in the system [3] .

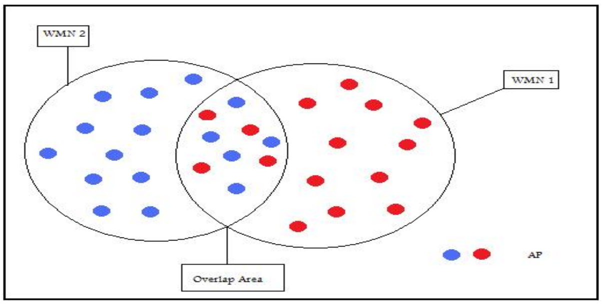


Fig. 2 Two wireless mesh networks with service area overlap

Model system with multiple WMNs in the concept of "network domain"; Let G=(V,E) be a connected graph representing the whole system ,V=set of mesh router (MR), E=set of directed links, Du is depending on wich network domain it belong to. Node MRu labeled with a domain variable Du, as shown in the Fig. 3.

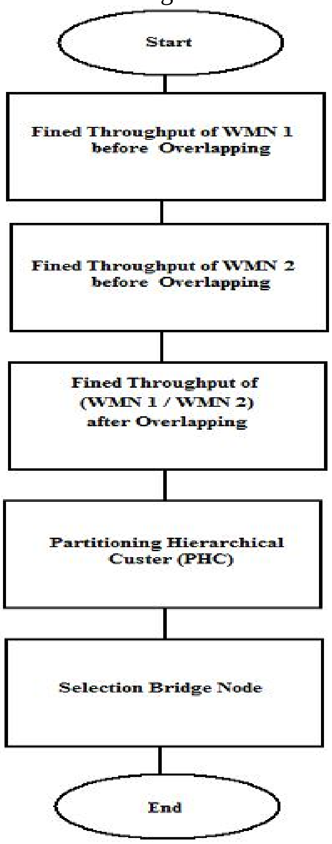


Fig. 3 Block Flow System Processing

A. Node Model

Mesh node with a multi mode 802.11a/b/g can be tuned to any mode to communication with nearly nodes depends on hardware configuration & these nodes can be active simultaneously or one at time, To model multi mode node Fu denoted the set of modes, 0=802.11b, 1=802.11g, 2=802.11a support node u, Tu effective number of radio that node u has eg. :
Tu =1==> node u (multimode a/b/g),
Tu =2==>node v ({2} multimode a/b/g)

And Fu =Fv= {0, 1,2}at a time
If node u is equipped with 802.11g only set Fu {0,1}➔{b,g}.
Distance d uv between node u,v should be with in common transmission range ie.
802.11a➔50 m
802.11b➔100m
802.11g➔150m

B. Connection Model

Link model Luv from node u to v, When u,v share at lest one common channel., M={0,1,2,3,4,5,6,7,8,9,…..,17}set of channel, MB={0,1,2}802.11b, MG={3,4,5}802.11g MA={6,7,8,…17}802.11a, Note 802.11g radio is backward compatible with 802,11b then 802.11g can use 6 channels MG $\cup$ MB={0,1,2,3,4,5}b,g operate at the same freq. band with different set of channel variables, Fu $\cap$ Fv $\neq$ empty.

C. Interference Model

In each MR users share the medium and employ the carrier sense multiple access with collision avoidance (CSMA/CA) MAC protocol to communicate with an other MR. The DATA-ACK hand shake used properly in 802.11, successful transmission require both sender & receiver free of interference, assume each node used same power for packet transmission with interference range R^I is fixed, two different links can transmit on common channel simultaneously if sender & reciver from other links is at least R^I apart of each other. duv,dxy are with in the common transmission range {Rtx=100m, R^I=120,dxy=180m }, luv, lxy can active at the same time if dux>= R^I, duy>= R^I, dvx>= R^I, dvy>= $R^{I,}$ note 802.11g,802.11b operate at the same frequency band MB,MG not necessary orthogonal even with different PHY may be used, there is interferences between b,g radio therefore in this model assuming channel in MB interfere with MG, let Ik interfere channel for channel k, I0={0,3},I4={1,4},I7={7}ie channel 802.11a, Luv operate on channel 0 and Lxv on channel 3, If dux,duy,dvx,dvy is lees than R^I then these two links are interfere with each other, Also when Luv operate on channel 1 then Lxv on channel 4, The same Luv operate on channel 2 then Lxy on channel 5, Euv set of links interfere with link Luv include Luv itself [8][9].

D. Cluster Model

- Partitioning Hierarchical Cluster (PHC)

The WMNs are divided into disjoined Partitioning Hierarchical Cluster (PHC), Assume WMNs is partitioned into several GW domains each domain consist of one GW, MR associated with it traffic between MR only exit in neighborhood no traffic in same level between MR Generation of connected GW Cluster[5], a connected GW cluster will be created by adding MRs. as shown in the Fig. 4.

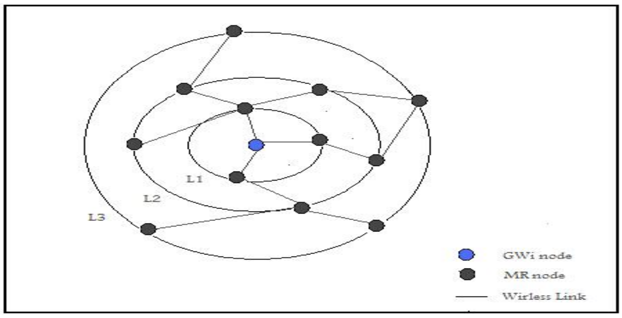


Fig. 4 Partitioning Hierarchical Cluster (PHC)

• *MR* selection: For each GW applicant *vi*, a breadth first Search (BFS) procedure is used to select the nodes from 1 hop away nodes to Rmax hop away nodes, and attach to the GW to form a connected GW cluster. In this way the closer neighbor MRs will be assigned before far away nodes, which achieve the shorter MR-GW path length. Node index will be used to break the connect if two nodes have the same metric, let S set of stores those nodes v which have been labeled (i.e., whose distance from s, L(v), has changed) in the previous iteration, and instead of trying to label the neighboring nodes from one single labeled node v, we try to label the neighbors from all nodes in S [3].

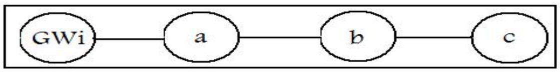
BFS Shortest-Path Algorithm

```
procedure BFS(G, s, t)
    S := {s}; L(s) := 0;
    for v ∈ V \ {s} do L(v) := ∞;
    while S ≠ ∅ do
        begin
            T := ∅;
            for v ∈ S do
                for w ∈ N(v) do
                    if L(w) > L(v) + ℓ_vw and L(t) > L(v) + ℓ_vw then
                        begin
                            L(w) := L(v) + ℓ_vw; P(w) := v; T := T ∪ {w}
                        end;
            S := T \ (T ∩ {t})
        end;
    P := ⟨t⟩; v := t;
    repeat
        v := P(v);
        P := v ⊕ P
    until v = s;
    BFS := P
end {procedure}
```

Fig. 5 BFS Shortest-Path Algorithm

For non-negative weights, the complexity of BFS is O(V +E) and, hence, the BFS algorithm is better suited for sparse graphs than Dijkstra's algorithm , (and the modified Dijkstra's algorithm in the case of negative weights). Still, the worst case, complexity of the two algorithms is the same (O(V 2)). An important feature of BFS is that it always finds the shortest path with the minimum number of hops (when more than one shortest path exists)[6].

• Constraints validation: At the same time of MR selection, the attachment of any number of MR to the connected GW should satisfy the constraints compulsory by GW throughput capacity and MR throughput. Each MR attached to one & only one GW i.e. MR relationship with GW=1, GW=0 with single or multi hop and with the minimum hops number between two nodes, relationship between neighbor hood nodes to GW=k =1 when



hop(i,c)-1=hop(i,b)➔3-1=2=2; hop(i,b)-1=hop(i,a)➔2-1=1
MR throughput >= traffic demand.

Throughput have upper transmission capacity of GW when all interfaces (transmit/received) with orthogonal channels MR-GW hops<=4, traffic through of MR within throughput capacity, flow generate from MR is same as that go to GW,

For gradual degradation interference model: request bandwidth of MR = changed from, local traffic of MR to (local traffic MR*(1+throughput per hop $)^{(no.hop-1)}$), two MR directly communicate if & only if they are in transmission range, index hop= average hop (reflect the transmission distance)[4].

E. Bridge Model

A key constraint in interworking multiple wireless mesh networks is to limit the number of bridge nodes B while maximizing the total network capacity, mesh node of the different domains don't communicate with each other, using bridge node to facilitate inert-domain traffic and this bridge node are equipped with multiple interface (802.11a, 802.11b) or need to perform protocol conversion between neighbor network domains like 802.11s, using node B to relay traffic for nodes in domain1 therefore shorter path and less congested rout from MR to GW, Bu =denote node u bridge, Node u can communicate with nodes in different domains only when Bu =1.

V. Discussion

This paper successfully to improved above goals, which to Enhancement Throughput of Unplanned Wireless Mesh Networks Deployment by Using Partitioning Hierarchical Cluster (PHC), the unplanned deployment of WMNs are determinates there performance. We use throughput optimization approach to model the unplanned WMNs deployment problem based on partitioning hierarchical cluster (PHC) based architecture we show that the routes when selection bridge nodes after clustering are more accurate with less trace node selection as bridge and noticeably better throughput more than the default shortest path routes even in presence MAC contention .

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