Performance Evaluation of VOIP in MultiHop Wireless Mesh Network

Kamal Kumar and Pooja Saini

Abstract
Wireless Mesh Network (WMN) is considered to be an effective solution to support multimedia services in last miles due to their automatic configuration and low cost deployment. The main feature of WMNs is multihop communications which may result in increased region coverage, better robustness and more capacity. Wireless mesh networks (WMNs) will play an important role in the next-generation wireless communication systems because it can support broadband services with ubiquitous coverage by low power consumption. Voice internet over protocol is an important services of wireless mesh network. Wireless Voip is more popular due to low cost and easy to deploy. Wireless mesh network is a good solution for Voip services deployment, performance evaluation. Performance is main challenges in QOS phase in this paper analyze four parameters to evaluate performance.

Keywords: WMN, VOiP, Throughput, Packet Delivery Ratio, End to End Packet Delay, Zitter.

Introduction
Wireless Mesh Network
Wireless Mesh Networks (WMNs) are an emerging two tier architecture based on multihop transmission. Wireless Mesh Networks (WMN) are gaining attention as a cost-efficient way for providing broadband wireless Internet access. The IEEE 802.11s task group is aimed to form a transparent 802.11 broadcast domain with the same functionality as its wired counterpart. Multi-hop WMNs have several benefits. In comparison to infrastructure networks with single wireless links, multi hop WMNs can extend the coverage of a network and improve the connectivity. The number of fixed Internet access point scan be reduced leading to a cheaper network access as several users share Internet connectivity by multi hopping towards the access routers. Multihop WMNs avoid a wide deployment of cables and can be rapidly deployed in a cost-efficient way. Incase of dense multi hop networks, the use of multi-radio multi channel multi channel mesh nodes increases network capacity, and therefore several paths might become available increasing the network’s robustness. The provisioning of VOIP in multi-hop WMNs is an important service for the future wireless Internet. However, VOIP service poses new challenges when deployed over a multihop WMN. Packet losses and an increased delay due to interference in a multiple hop network can significantly degrade the end-to-end VOIP call quality. High traffic leads to high medium contention which increases packet loss rates compared to single hop deployments.

The existence of potential hidden nodes further intensifies this problem. Moreover, the transmission of small (voice) packets imposes a high MAC layer overhead, which leads to a low capacity for VoIP over IEEE 802.11-based WMNs.

The main function of the networking layer is to transfer the packets from the source to the destination over multiple hops. In this respect, WMNs are radically different from 3G systems, WLANs and WMANs. All these technologies use a single wireless link, and hence have no need for a network layer. In contrast, for WMNs and MANETs the source and the destination can be several wireless hops away from each other, and hence the packets have to be routed and forwarded in the wireless network itself. Wireless mesh networks (WMNs) will play an important role in the next-generation wireless communication systems because it can support broadband services with ubiquitous coverage by low power consumption.

Performance evaluation and analysis of different VOIP over WLAN mobility schemes is essential in order to meet adequate QoS levels in VoWLAN deployments. Voice over Internet Protocol (VoIP) service has been every popular and important application over the Internet. Wireless VOIP also becomes more and more popular due to its features of low cost and convenience. Recently, wireless mesh network has been considered as a good solution for VOIP services since it is easy to deploy and provides a larger area coverage. However, the security and performance are the main challenges.

This paper presents a study of real time voice communication QoS in terms of delay, jitter, throughput and packet loss between three different Wireless Mesh Network mobility schemes in a crowded 802.11 environment. The rest of the paper is organized as follows. Section 2 provides an overview of the literature survey. Section 3 explains the problem formulation. Section 4 explain the methodology to evaluation of VOIP performance. Finally, Section 5 explain the Future scope of the paper.
Packet Loss And Duplicate Packets
For these tests, we simulated a VOIP call by programming a Python script that sent 160-byte length UDP packets every 20 ms, thus generating a 64kbps stream. We implemented a Java script that sniffed the incoming packets in order to calculate packet loss. Because of the redundant multipath routing nature of SMesh generating duplicated packets, we also added a sequence number on the data portion of the packet. Our study determined that the wireless mesh networks presented higher QoS levels compared to a data only 802.11 infrastructure network. Our study also determined that GARP broadcasting schemes provide the lowest delay values, but more unstable throughput. Seamless handoff solutions with redundant multipath routing, such as SMesh, provide the most stable throughput as well as acceptable QoS values for real time voice communication [1].

This Section handles the MeshBed which is a next generation WLAN based Wireless Mesh Network, developed and deployed at T-Systems in Darmstadt, Germany. In its current state the MeshBed consists of 10 Mesh Router Nodes (MRNs) and 2 Mesh Gateways (MGWs) that are all deployed indoors. As hardware platform an embedded AMD Geode SC1100 Systems with 266 MHz CPUs and 64 MB of RAM is used. For nodes that require more processing power, e.g. MGWs, bare bone desktop PCs with 3 GHz Intel Pentium 4 processors and 1 GB of RAM are used. All mesh nodes are equipped with Atheros Wireless Mini PCI WLAN cards as well as Ethernet ports and use operating systems based on Linux together with "madwifi" an open-source WLAN driver. This mesh environment is designed in accordance with a strategy towards 802.11s, which assumes the usage of advanced MAC technique, namely link layer routing. Currently, packets are still routed at the network layer. The testbed emulates dual-radio feature, we call it pre-IEEE 802.11s. The paper addresses the deployment VOIP service in pre-IEEE 802.11s WMN and means for its performance optimization. VOIP, being a part of Triple play service bundle, was chosen as a reference service for extensive measurements. The general finding of the experiments is, that VOIP can be supported with good quality in mesh environment. However, under high load, quality drops and additional mechanisms are needed to overcome these problems. Moreover, it was demonstrated how the VOIP traffic may benefit from the small packet aggregation. A novel hop-by-hop packet aggregation mechanism was proposed. It significantly improves the performance of VOIP traffic in WMNs and reduces MAC layer busy time. [2]

Wireless Mesh Networks (WMNs) are an emerging two tier architecture based on multihop transmission. In Akyildiz et al. give a complete overview of WMNs, with an analysis of the challenges and the open issues for this kind of networks. Improving the performance in face of unreliable wireless medium is among the key factors affecting the scalability, and will support WMNs become a very cost-effective solution for wireless ISPs. In such context, routing has a crucial importance and a deep impact on the overall network performance, due to the unpredictable behavior of the wireless channel and the strong layering of the protocol stack. DeCouto et al. in showed that routing in multi-hop wireless networks using the traditional Shortest-Path metric is not a sufficient
condition to construct good paths. By good paths we mean paths able to effectively transport data with reasonable delay, throughput, and reliability. Indeed, the shortest-path metric does not take into account the variable quality of the wireless link. As a consequence, there is the need for the protocol stack to be aware of the nature and capabilities of the lower layers.

Giving to the routing layer the awareness of key parameters of the underlying layers enables the possibility to make smarter path selection. Note that this does not mean to sample some parameters at routing layer, like quality of service (QoS) routing, but to sample some parameters at the layer where they pertain, and allow exchanging this information with the routing layer. Several routing approaches proposed in the literature rely exactly on this idea, i.e. to use a set of parameters from the Physical or Data-Link layer in order to characterize the quality of a link and consecutively make routing decision. The solution proposed and evaluated in this paper is such a cross layer routing approach based on interaction between MAC layer and Network layer. Through carefully study of IEEE 802.11 MAC layer, we find that the retransmission mechanism of lost packets has a strong impact on link throughput and end-to-end latency along the path. The expected transmission efficiency (ETE) metric based on it finds path with the highest transmission efficiency required to deliver a packet. ETE estimates the success rate of sending data using per-link measurements of DATA/RTS retransmission. Thus it is a good estimate of both channel condition and congestion. [4]

Scheduling is one of the main issues in maintaining network performance. As the efficiency objectives in MAC layer are throughput and delay, scheduling criteria for wireless networks include:

- Efficiency, Applicability, QoS support, and Fairness. Although in order to support QoS, differentiate services are preferred in general, however, this is not feasible in mesh network architectures. Therefore, it seems that necessary design for a QOS centric architecture to support appropriate scheduling services within this framework still requires more investigations. 802.16 Standard defines two centralized and distributed scheduling schemes to coordinate using simultaneous mini slots (MSs) in data sub-frames. The centralized scheme in mesh mode is managed by Base Stations (BSs) to form a scheduling tree whose root is BS itself. Centralized scheme applies a 2-way handshaking for source transmission requests to be granted in data sub-frames. Distributed scheduler cannot be used for bandwidth allocation to links that are not present in scheduling tree; therefore, in such cases horizontal links will be overlooked. In this model, each node competes with communicational nodes within its two hop distance to acquire bandwidth.

The distributed scheduling itself is classified to coordinated and non coordinated categories. The coordinated distributed scheduling schedulers allow mesh nodes to transmit distributed scheduling signaling messages that contain bandwidth requests in control sub-frames, without any collision. In coordinated distributed scheduling, nodes schedule their transmissions with their two adjacent hopes using a three-way handshaking (request, grant and grant confirmation) for reservation of bandwidth in a link. To perform a non-collision scheduling, each node memorizes (locally) the positions of MSs based on information obtained from its neighbours. 802.16 standard employs an election distributed algorithm to access to transmission opportunities in control sub-frames so that when a node is in transmission, no other node at least within its two hop neighborhood attempts to transmit simultaneously.

This ensures that neighbors of a node are more likely to be able to receive the transmitted control messages properly. In non-coordinated distributed scheduling, similar mechanism to that of coordinated distributed scheduler is used with only difference in mesh election algorithm. This difference lies in the fact that handshaking messages transmitted in data subframes and in MSs, are reserved for specified links instead of being transmitted in control sub-frames. The framework for request process and allocation of bandwidth by 802.16 standard is defined. WMNs had been viewed as networks that fail to meet multimedia QoS requirements due to using multi hop wireless communications. However a number of investigations have led to solve some WMN dmwbacks but still a lot of unsolved problems persist. Mesh network scheduling has also been one of the centers of attention. Some proposed centralized scheduling for inter-mesh flows have been able to provide end to end QoS. But distributed scheduling provides facilities for intra-mesh traffic between client stations. Such a scheduling model does not provide end to end QoS for flows but makes mesh network suitable for situations in which a resistant and scalable ad hoc network is needed [6].

Problem Formulation
Performance Evaluation of VOIP in (MultiHop Wireless Mesh Network) using different performance throughput, packet delivery ratio, end to end delay and “zitter”.

Methodology
The evaluation is carried out with the GloMoSim simulator by performing several experiments that illustrate the performance of the system. The simulation parameters like number of nodes, terrain range etc. Along with their respective values are used to examine the performance of the network. These parameters are available in the “config.in” file present in the GloMoSim. The values can be adjusted according to requirements in this file. After adjusting the values in this file, this file is executed. An output file “glomo.stat” is used to check the various parameters to analyze the performance of network.

The performance metrics used for evaluation are:

Average Throughput
Defined as packets received successfully to given time interval.

End To End Delay
Network delay is the total latency experienced by a packet to traverse the network from the source to the destination. At the network layer, the end-to-end packet latency is the sum of processing delay, packet, transmission delay, queuing delay and propagation delay.
Packet Delivery Ratio (PDR)

\[ PDR = \frac{\text{Total number of packets received}}{\text{Total number of packets sent}} \]

ZITTER
Based on different parameters VOiP are simulated and analyzed. All four parameters are evaluated by finding out average throughput, end-to-end delay and PDR, Zitter by varying number of nodes and node mobility. [7]

Future Scope
Using above four parameters evaluate performance of VOiP in WMN and result would be simulate using GloMoSim simulator. By using different scenarios analyze values to given parameters.

References


