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Analysis of Various Parameters which Affect Voice Transmission in Wireless Mesh Network

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Abstract: The use of Voice over Internet Protocol (VoIP) inwirelessLAN has become an important Internet application. For next generation wireless networks, ensuring high performance in multimedia applications like VoIP is an indispensable requirement. Wireless Mesh Network(WMN)can be used as a powerful technology to be used for multimedia application. However, there exist various challenges for VoIP in WMN. In this Paper, thevoice qualityis represented in terms of Mean Opinion Score and R-Factor. Through this paper, we analyzed various parameters like routing protocols, signaling protocols, routing metrics and different coding algorithms which affect voice quality in WMN.

Keywords: H.323, SIP, HWMP.

I. INTRODUCTION

Research in Wireless Mesh Networks has recently drawn the eyes of the International technical community.Theyprovide self-organized network and are similar to an ad hoc network but contain static mesh backbone routers. It mainly has 2 types of infrastructure nodes i.e. Mesh Clients(MCs)and Mesh routers(MRs). Mesh Points work without any energy constraints and thus have minimal mobility. WMN contain mesh routers which are static and consider client as a mobile node.
WMNhas emerged as animportant model for VoIP due toits self-configuration; static infrastructure and self-healing.WMNs infrastructure contains various mesh routers, in which some of them make a link with the gateway in a direct manner. Further, these routers make interconnection with the clients[1],[2].

The main application of WMN is anytime, anywhere.There are various features which have been added into the ad hoc networking to make it equivalent to WMN[3].These features are robustness, easy deployment, low cost of installation, huge coverage etc. [4].Due to these advantages, WMN is used more than other wireless networksPresently, Wireless Mesh Networks are witnessing high use in applications such as automation in building community based networking,commercialization and broadband home networking[5].In wireless mesh network, traffic is transferred through a no. of hops between devices. The throughput, delay and other QoS Parameters depend upon the number of hops the traffic has to pass through.In WMN having n intermediate hop, the traffic is passed only n times over the medium.So, the configuration of all the devices in WMN will represent how the traffic will be passed through the network.

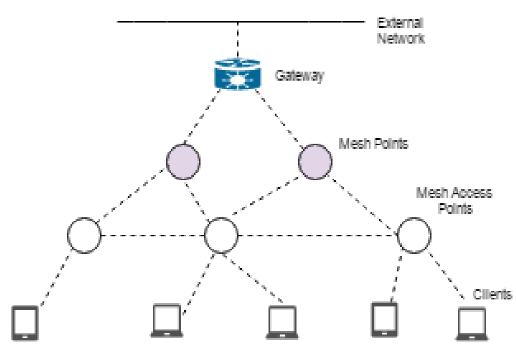

Fig.1: Wireless Mesh Network

II. VOIP TECHNOLOGY

Voice over Internet Protocol (VoIP) [6], [7] is an Internet Protocol whichtransport audiodata packets acrossthe network. It involvesvoice streamdigitization [8].Now a days, as there is more usage of Wide Area Network than Local Area Network; it has become a necessity to check whether QoS parameters of VoIP are comparable to the traditional PSTN Network.Here Figure 1 represents the transmission of the voice in the VoIP Network.With the increase in popularity of 802.11 based WMNs,various methods are being under research for finding Quality of Service over it.

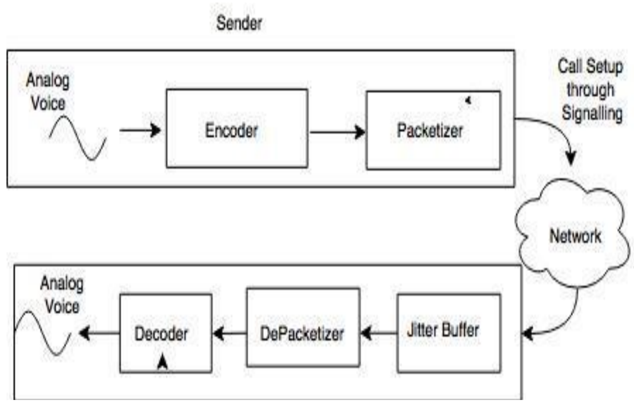

Fig.2: VoIP Transmission

For a typical VoIP application, a voice signal goes through the process of sampling, digitization, and encoding with the help of codec. After encoding of the data, the data is packetized in the form of packets. At destination, reverse process of packetization i.e.depacketization of packets is done and are forwarded to a jitter buffer so that the traffic at the receiver gets smoothed.At destination, the audio signal is again converted to its original form as was sent at the destination.

III. QOS PARAMETERS OF VOIP

E-Model [11] defines various evaluation parameters for finding the quality of voice.The parameters include R-Factor and MoS.The formula for R-factor considersdelay, packet loss, and type of compression algorithm. Theformula for the R-Factor [6]is given in equation (1):

$$R = R_0 - I_e - I_s - I_d + A_d \qquad (1)$$

Here, R_0 representsquality of voice without any impairment,I_s representsimpairment due to packet loss, $I_d$refers to loss due to jitter,$I_e$shows loss due to encoding and $A_d$is theAdvantage Factor.

The other parameter which can be used for calculating the quality of VoIP is Mean opinion Score[6].It is recommended by ITU-T for representing the subjective parameter for the quality of VoIP. In finding Mean Opinion Score, various people rate the performance of the voice from 1 to 5. On the basis of their rating, voice quality can be categorized as Good,Average or Poor.Mean Opinion Scoremakes it very easy to make comparison between the different voice streams. The main limitation is the hiring of so many listeners for listening the sentences. There are also various other objective evaluation parameters which can be used for finding the quality of voice. E-Model[7] is recommended by ITU-T which gives call performance based on various factors in network. E -model takes into account a wide range of impairments, such as CODEC choice, end-to -end delay, packet loss and jitter. With these inputs, the E-model produces a rating factor, R. This rating factor can be transformed to give an estimated MOS value, which we use for measuring call quality in our experiments. One drawback of any call quality calculation such as the E-model is that it is only an estimate of sound quality. It does not test actual sound quality, but estimates are based on the performance metrics measured on the network. In voice communications, particularly Internet telephony, the Mean Opinion Score (MoS) provides an aggregate numerical measure of the quality of human speech at the destination end of the circuit. The scheme uses subjective tests (opinion scores) that are mathematically averaged to obtain a quantitative indicator of overall quality [8].

There are various technical factors like echo, delay and distortion which can be calculated by various methods but the subjective factors cannot be calculated by the technology, so there emerges a requirement of MoS. Both R-factor and MoS are interdependent on each other.
Upto now, very little research work has been done for investigating the performance of VoIP over WMNs.The quality of a VoIP Call depends upon the Routing protocols i.e. reactive or proactive required to route voice packets, routing metrics, the type of codec used and the signaling protocol used.

IV. MESH ROUTING PROTOCOLS

In wireless mesh network, the classification of routing protocols can be categorized as: Reactive, Proactive and Hybrid Routing Protocols[9].Various Proactive routing protocols are DSDV, OLSR. The reactive protocols can be defined as AODV,DSR. Also the Hybrid routing protocolswhich are broadly used are HWMP, HSLS.

The various routing protocols which can be used for communication of traffic in wireless mesh network can be proactive (e.g. DSDV, OLSR),Source initiated Reactive Routing protocols (e.g.AODV, DSR) and Hybrid Routing Protocols (e.g. HWMP, HSLS)

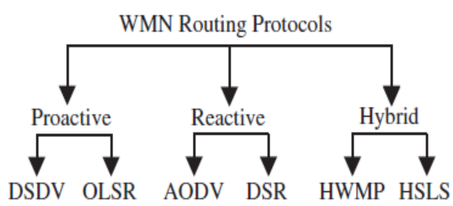

Fig. 3: Mesh Routing Protocols

Adhoc on Demand Distance Vector (AODV)

AODV[10] is a reactive routing protocol used as an on demand routing protocol.It design routes as per demand or as desired by the starting node. Request (RREQ) is transferred to every node from the sender so that route can be established. On getting RREQ, the route reply i.e. RREP is generated and is transferred back to the sender. If any link fails or there occurs any type of error, Route error reply i.e. RERR is generated. After receiving RERR, source node can again start with the route discovery process. The main advantage of AODV is that it creates routes only when source has some packets to send. The route gets inactive when source does not have any data to send. As the routes are created when needed, it allows the nodes to enter or leave the network at their own will.It uses sequence numbers to ensure that there are no loops while routing. Every node maintains a sequence number which increases monotonically every time node notices change in neighboring nodes.

Dynamic Source Routing (DSR)

The Dynamic Source Routing protocol (DSR)[12] is basically used in multi-hop wireless ad hoc networks of mobile nodes. When node (Source) wants to send a packet to another node (Destination), but does not know the route, it initiates a route discovery, also called On-demand or reactive routing. Every node contains a Routing Database in which it maintains a complete route to recent destinations in the form of list. If some required destination is on the list, it just uses that route from the list to reach the destination, if not, it broadcasts a Route Request (RREQ) to all neighbors. DSR has the same working as AODV i.e. it makes a route on demand request while making any communication.But it mainly uses source routing rather than routing table lying at every node.

Destination-Sequenced Distance-Vector Routing (DSDV)

DSDV [12] is an algorithm based on Bellman Ford algorithm.It is a table driven routing protocol which is developed by C. Perkins and P.Bhagwat.In DSDV, nodes require regular update information related to routing tables.DSDV requires a regular update of its routing tables, which uses up battery power and a small amount of bandwidth even when the network is idle. Whenever the topology of the network changes, a new sequence number is necessary before the network re-converges; thus, DSDV is not suitable for highly dynamic networks.

Optimize Link State Routing (OLSR)

This is a proactive routing protocol which actually maintains data about topology of the network .Every node in the network sends messages titled "HELLO" with predefined intervals.OLSR uses Multipoint Relays (MPRs) for sending the control traffic to the neighboring nodes.

Hybrid Wireless Mesh Protocol(HWMP)

This protocol is a hybrid mesh routing protocol used in 802.11 s standard. It combines the advantage of both AODV routing protocol which find the minimum distance between sender to receiver and the Proactive spanning tree building method from root to the destination node. TheOLSR and HWMP are having less packet delivery delay than AODV due to their proactivenature of establishing routes which causes saving of additional timefor setting up the new route [15].

V. ROUTING METRICS

Ghannay[10] discusses the routing metricsi.e. Hop Count, RTT(Round Trip Time), Load Count and ETX (Expected Transmission Count) etc. The main routing metric, Hop Count, is a routing metric which considers minimum distance between the sender and receiver. InRTTi.e. Round Trip Time , time between sending probe from sender and acknowledgement from receiver is considered, load count maintains the load on each node i.e. the remaining number of voice packets in the buffer to be transmitted at each node. Another metric called ETX gives the expected no. of transmissions on every link.

VI. VOIP SIGNALING

To establish aconnection between VoIP endpoints, ITU has recommended mainly 2 signaling protocols i.e. H.323 and Session initiation protocol (SIP). H.323 architecture consists of 4 components i.e. Terminals, Gateways, Gatekeepers and Multipoint control units (MCU) [9]. Terminals are the endpoints of the network which perform the voice communication. Gateways are optional in the H.323 architecture which provides the function of protocol translationbetween different end points. Gatekeepers perform address translation, call authorization and manage the bandwidth to be used by different endpoints.MCUs support callsetup between multiple endpoints.Fig. 4 represents the H.323 Network. In SIP architecture, the end points make a phone call using request and response messages communicated via proxy server.

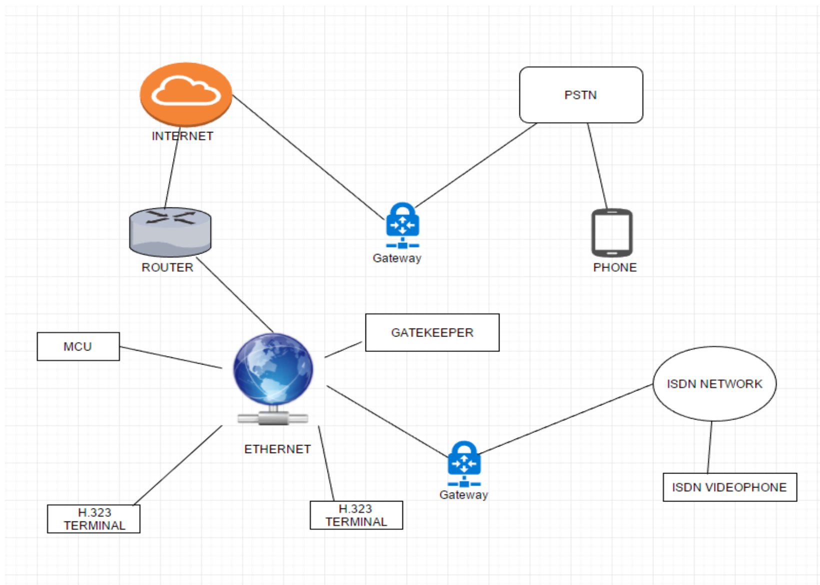

Fig. 4: H.323 Network

Here, proxy server can be used both as server or client on behalf of some other SIP client. The registrar end point in SIP architecture handles the request from the user end point regarding location service. It links the IP Addresses of the endpoints with the corresponding uniform resource identifier (URI).As signaling protocols can affect the call establishment, call authorization; the use of different signaling protocols can affect the voice quality to be transferred over the medium.

VII. VOIP CODECS

Coder at the source encodes the voice signal at the sender and the decoder at the receiver decodes the voice at the receiver [9] .In real life scenarios, different codecs can be used to encode the voice.G.711 is the traditional codec which uses the technique of Pulse code modulation and generates the voice stream at 64 kbps.G.723.1 transfers the voice stream at 5.3 Kbps which uses the technique of Algebric Code excited linear prediction algorithm (ACELP).With a bit rate of 8 Kbps, G.729 codec uses Conjugate –Structure Excited Linear prediction (CS-ACELP) algorithm. All these voice codecs transfer the voice signal at different bit rates causing different sizes of voice payload to be transferred through the medium.

Table1: Different types of Codecs [6]

CODEC	Sampling rate(Kbps)	Sample period (bytes)
PCM,G.711	64	20
ACELP, G.723.1	5.3	30
CS-ACELP, G.729	8	10

VIII. CONCLUSION

This paper has reviewed various parameters which affect the quality of voice in a wireless mesh network.TheQoSparameters which can be measured for voice traffic are R-Factor, Mean Opinion Score and Average one way delay. Various codecs (G.711, G.723, and G.729) can be applied for coding of voice traffic over wireless mesh network. This paper helps us to make a decision over the selection of appropriate routing protocol, signaling protocol and codec during the transmission of voice traffic over Wireless mesh network.

REFERENCES

[1] Wang, X., & Lim, A. O. (2008). IEEE 802.11 s wireless mesh networks: Framework and challenges. Ad Hoc Networks, 6(6), 970-984.

[2] Bruno, R., Conti, M., & Gregori, E. (2005). Mesh networks: commodity multihop ad hoc networks. IEEE communications magazine, 43(3), 123-131.

[3] Tsai, T. J., & Chen, J. W. (2005, March). IEEE 802.11 MAC protocol over wireless mesh networks: problems and perspectives. In Advanced Information Networking and Applications, 2005.AINA 2005.19th International Conference on (Vol. 2, pp. 60-63).IEEE.

[4] Mahmud, S. A., Khan, S., Khan, S., & Al-Raweshidy, H. (2006, September). A comparison of MANETs and WMNs: commercial feasibility of community wireless networks and MANETs. In Proceedings of the 1st international conference on Access networks (p. 18). ACM.

[5] Hiertz, G. R., Denteneer, D., Max, S., Taori, R., Cardona, J., Berlemann, L., & Walke, B. (2010). IEEE 802.11 s the WLAN mesh standard. IEEE Wireless Communications, 17(1).

[6] Goode, B. (2002). Voice over internet protocol (VoIP). Proceedings of the IEEE, 90(9), 1495-1517.

[7] Cai, L., Xiao, Y., & W Mark, J. (2006). VoIP over WLAN: Voice capacity, admission control, QoS, and MAC. International Journal of Communication Systems, 19(4), 491-508.

[8] Nisar, K. (2010). A comprehensive review on VoIP over Wireless LAN networks. Computer Science Letters, 2(2).

[9] Mohseni, S., Hassan, R., Patel, A., & Razali, R. (2010, April). Comparative review study of reactive and proactive routing protocols in MANETs.In Digital ecosystems and technologies (DEST), 2010 4th IEEE international conference on (pp. 304-309).IEEE.
[10] Ghannay, S., Gammar, S. M., Filali, F., & Kamoun, F. (2012). Multi-radio multi-channel routing metrics in IEEE 802.11 s based wireless mesh networks. annals of telecommunications-annales des télécommunications, 67(5-6), 215-226.
[11] Waharte, S., Boutaba, R., Iraqi, Y. and Ishibashi, B.(2006). Routing protocols in wireless mesh networks:challenges and design considerations. Multimedia tools and Applications, 29(3), pp.285-303.
[12] Singh, R., Singh, D. K., & Kumar, L. (2011). Performance Evaluation of DSR and DSDV Routing Protocols for Wireless Ad Hoc Networks. Int. J. Advanced Networking and Applications, 2(04), 732-737.
[13] Bagwari, A., Jee, R., Joshi, P., & Bisht, S. (2012). Performance of AODV Routing Protocol with increasing the MANET Nodes and its effects on QoS of Mobile Ad hoc Networks. In Communication Systems and Network Technologies (CSNT), 2012 International Conference on (pp. 320-324). IEEE.
[14] Clausen, T., & Jacquet, P. (2003). Optimized link state routing protocol (OLSR) (No.RFC 3626).
[15] Piechowiak, M., Zwierzykowski, P., Owczarek, P., & Wasłowicz, M. (2016). Comparative analysis of routing protocols for wireless mesh networks. In Communication Systems, Networks and Digital Signal Processing (CSNDSP), 2016 10th International Symposium on (pp. 1-5). IEEE