Design and Implementation of INFO Protocol for Collecting the Information of Neighbourhoods Nodes and Their Bandwidth in IEEE802.11e: A Survey

Mukhtiar Singh¹, Maninder Singh²
Department of computer science
Punjabi University-Patiala

Abstract- The wireless networks are growing the popularity since the last decades, where the wireless networks have been grown to the variety of the applications. The wireless networks have been utilized in the form of the cellular networks, wireless local area networks (WLAN), Wi-Max, Bluetooth, etc. The wireless networks range from personal area networks to the wide area networks, which creates the applications according to the requirement. The wireless LAN (WLAN) is the most prominent networks in the campus areas, buildings, homes, offices, and many other places. 802.11 is the IEEE standard, which allows the network appliances such as laptops, phones, tablets, etc. to the wireless access point in the home, office or other commercial deployments. The WLAN models offer the higher bandwidth, which ranges from 10 Mbps to Gigabytes over the different wireless standards, such as 802.11a, 802.11b, 802.11n, 802.11e, etc. IEEE 802.11e is the wireless network standard amendment for the inclusion of the quality of service (QoS) in the WLAN networks for the handling of the data prioritization over the media access control (MAC) layer. The 802.11e standards have played the significant role in the critical data handling by the means of the quality of service (QoS) standardization. The QoS is used for the handling of the different kinds of the data streams with the different priorities in order to minimize the network latency for the important and critical data. In this paper, the proposed model has been designed for the smart bandwidth allocation over the quality of service channel across the 802.11e based wireless standard for the smarter wireless application.

Keywords- AODV, QoS Routing, Estimation, Interference Phenomena.

I. INTRODUCTION

Wireless network also called Wi-Fi. Wi-Fi refers to "wireless fidelity" that means as "Networks with no wires". In networking terminology, wireless is the time period used to describe any computer network the place there is no physical wired connection between senders to the receiver, but rather the network is connected by radio waves, infrared waves or microwaves to maintain communications. Wi-Fi is a technology that makes it possible for digital instruments to hook up with a wireless LAN (WLAN) community that uses radio waves to provide Wi-Fi high-velocity internet and network connections. A WLAN is traditionally password included, however, could also be open, which makes it possible for any device inside its range to access the resources of the WLAN community. A wireless network enables people to access applications and information and communicates without wires. This provides freedom of movement and the capability to expand applications to different parts of a building, city, office, home or nearly anywhere in the world. Wireless networks allow people to interact with browse the Internet or E-Mail from a location that they prefer. Many types of wireless communication systems exist, but a different attribute of a wireless network is that communication takes place between computer devices. Wireless networks use radio waves to connect devices such as laptops to the Internet, applications, and the business network. When laptops are connected to Wi-Fi hot spots in the public places, the connection is established to that business’s wireless network.
II. IEEE 802.11

IEEE (Institute of electrical and electronics engineers) was launched in 1997. The 802.11 WLAN standards. As the name suggests, it refers to the group of popular IEEE 802.x standards, e.g., IEEE 802.3 for Ethernet, IEEE 802.5 for Token Ring, and IEEE 802.11 defines Physical layer (PHY) and Media Access Control (MAC) specifications for wireless LANs. Three exceptional Physical layer specifications have defined, (1) DSSS referred to as Direct sequence spread spectrum (2) FHSS referred to as Frequency hopping spread spectrum , (3) IR referred to as Infrared, with the maximum data transmission rate of up to 2Mbps. The DSSS and FHSS Physical layers operated in the license free 2.4GHz ISM (Industrial, Scientific, and Medical) band. IEEE 802.11 defines two different architectures, Independent IBSS (Basic Service Set) and BSS (Basic Service Set). In a Basic Service Set, a number of wireless stations, called STAs, is associated to an AP (Access Point). All communications take place via access-point (AP). In an Independent BSS, STAs can direct communicate to each other, providing that they are within every different transmission range. This form of structure is facilitated to kind a wireless ad-hoc network in the absence of any network infrastructure. Several BSS can be connected together through a DS (Distribution System) to form an extended network, called ESS (Extended Service Set). IEEE 802.11 defines two different access mechanisms, the mandatory IBSS (Basic Service Set) and BSS (Basic Service Set). In a Basic Service Set, a number of wireless stations, called STAs, is associated to an AP (Access Point). All communications take place via access-point (AP). In an Independent BSS, STAs can direct communicate to each other, providing that they are within every different transmission range. This form of structure is facilitated to kind a wireless ad-hoc network in the absence of any network infrastructure. Several BSS can be connected together through a DS (Distribution System) to form an extended network, called ESS (Extended Service Set). IEEE 802.11 defines two different access mechanisms, the mandatory DCF (Distributed Coordination Function) which supplies distributed channel access based on CSMA/CA refers to Carrier Sense Multiple Access/Collision Avoidance, and the optional PCF (Point Coordination Function) which provides centrally controlled channel access through polling.

III. IEEE 802.11e

IEEE 802.11e is currently working on a new standard, called IEEE 802.11e, which upgrade the version of the legacy 802.11 Media Access Control in order to support quality of service. IEEE 802.11e is in the standardization process and the final draft has been released. IEEE 802.11e supports quality of service. All types of data traffic are not dealt with equally as it is done in the original standard. 802.11e supports service converse by assigning data traffic with other different priorities based on their quality of service (QoS) requirements. More ever, four different Access Categories (AC) have been defined each for data traffic of a different priority. Access to the medium is then permission based upon the priorities of data traffic, such as each frame with an appropriate priority is mapped to an Access Category, and service disparity is realized by using a different set of argument parameters to contend for the medium, for each Access Categories. In IEEE 802.11e, the AP and STA that provides QoS services are invoked to as QAP (QoS Access Point) and QSTA2 (QoS Station) respectively, and the BSS that is operating in is called QBSS (QoS Basic Service Set). IEEE 802.11e originates a new coordination function, called as Hybrid Coordination Function (HCF). Subsequent sections describe HCF together with the detailed description of its service converse mechanism.

III. HCF (Hybrid Coordination Function)

IEEE 802.11e defines a new function that is also known as Hybrid Coordination Function (HCF). Hybrid Coordination Function is a centralized coordination function that combination of DCF and PCF with upgrade QoS mechanisms to provide service differentiation. HCF provides service both distributed and centrally controlled channel access mechanisms related to DCF and PCF in the original standard. The distributed, contention-based channel access mechanism of HCF known as EDCA refers as Enhanced Distributed Channel Access, and the centrally controlled, contention-free channel access mechanism says that HCF Controlled Channel Access (HCCA). IEEE 802.11e introduces Transmission Opportunity, defined as the limited time, which a QSTA has the right to transmit. In other words, we can say that 802.11e when a station gets access to the medium; it says that permission the TXOP. TXOP is characterized by at the start time and a maximum time period called TXOP Limit. As a QSTA gets the TXOP, it can then start transmitting frames such that the transmission duration does not overtake the TXOP limit. TXOP Limit is specified by the QAP. The next section describes EDCA, the distributed access mechanism of HCF. The detailed functionality of the centrally controlled access mechanism HCCA is beyond the scope of this report as we focus on the EDCA.
III.II EDCA (Enhanced Distributed Channel Access)

The EDCA that can provide differentiated, distributed access to the medium different types of data traffic for using different priorities. The detailed description of the components and operation of EDCA is presented next.

III.II.I Access Categories (ACs)

Enhanced distributed channel access (EDCA) defines four Access Categories (ACs) for different types of data traffic and as well as service variation is represented such that for each AC, a further set of parameters is used to contend for the medium. These parameters are referred to as EDCA parameters and are described in the next subsection. From different types of data traffic are Frames plotted into different ACs depending on the QoS requirements of the traffic/application? The four Access Categories (ACs) are named AC_BE (Best Effort), AC_BK (Background), AC_VO (Voice data traffic), and AC_VI (Video), where AC_BK has the lowest and AC_VO has the highest priority. Each frame from the higher layer reached at the MAC layer along with a priority value. This priority value is referred to as UP (User Priority) and assigned according to traffic the frame or the type of application belongs to. There are eight different priority values ranging from 0 to 7.

Table 1: User Priority (UP) to Access Category (AC) mappings.

<table>
<thead>
<tr>
<th>Priority</th>
<th>User Priority (UP)</th>
<th>Access Category (AC)</th>
<th>Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lowest</td>
<td>1</td>
<td>AC_BK</td>
<td>Background</td>
</tr>
<tr>
<td>.</td>
<td>2</td>
<td>AC_BK</td>
<td>Background</td>
</tr>
<tr>
<td>.</td>
<td>0</td>
<td>AC_BE</td>
<td>Best Effort</td>
</tr>
<tr>
<td>.</td>
<td>3</td>
<td>AC_BE</td>
<td>Best Effort</td>
</tr>
<tr>
<td>.</td>
<td>4</td>
<td>AC_VI</td>
<td>Video</td>
</tr>
<tr>
<td>.</td>
<td>5</td>
<td>AC_VI</td>
<td>Video</td>
</tr>
<tr>
<td>.</td>
<td>6</td>
<td>AC_VO</td>
<td>Voice</td>
</tr>
<tr>
<td>Highest</td>
<td>7</td>
<td>AC_VO</td>
<td>Voice</td>
</tr>
</tbody>
</table>

How to assign such a priority to each frame is a higher layer implementation issue. Interestingly, the draft standard does not specify anything how such a priority is assigned to the higher layers. Generally, it can be assigned by the user using the application or by the application generating the traffic. The latter solution indicates that every application has to be updated in order to be compatible with 802.11e. Another possibility would be to adaptively assign the priority at the Application layer, based upon the traffic characteristics e.g., data rate, packet interval, packet size etc. How this priority will travel through different layers down to the MAC layer further indicates that modifications at the higher layers would be inevitable. At the MAC layer, a frame with a particular UP is further mapped to an AC. ACs are derived from the UPs as illustrated in Table 1.

III.II.II EDCAF (Enhanced Distributed Channel Access Function)

Each and every station maintains have four transmit queues one for each AC, and four independent EDCAFs, one for each queue, as illustrated in Figure 1. EDCAF is an enhanced version of DCF, and contends for the medium on the same principles of CSMA/CA and backoff, but based on the parameters specific to the AC it is contending for.

Fig 1: Four ACs, each with its own queue, AIFS, CW, and backoff timer.

III.II.III EDCA Parameters

An EDCAF contends for medium based on the following parameters associated to an AC:

- **AIFS** - The time period the medium is sensed idle before the transmission or backoff is started.
- **CWmax and CWmin** - The size of Contention Window used for backoff.
- **TXOP Limit** - The maximum time period of the transmission after the medium is collected.

The values of EDCA parameters are different for different ACs. The higher priority ACs wait for small AIFS duration while the lower priority ACs have to
wait a longer AIFS time before they approach the medium. The size of CW varies such that the higher priority ACs chooses backoff values from a smaller CW as compared to the lower priority ACs. TXOP Limit is also set in a way that the higher priority ACs get the access to the medium for long time period. The higher priority of an AC, the smaller the AIFS, CWmax, and CWmin, and larger the TXOP Limit. The values of EDCA parameters are AC specific, they are referred to as AIFS[AC], CWmin(AC), CWmax(AC) and TXOP Limit(AC). The main difference between DCF and EDCAF is that uses AC specific parameters AIFS(AC), CWmin(AC) and CWmax(AC) rather than using fixed values DIFS, CWmin, and CWmax. EDCA parameters are periodically advertised by the QAP. QAP can modify these parameters dynamically depending on the network conditions. The draft standard indicates default values of EDCA parameters if not advertised by the QAP.

Table 2: Default EDCA parameter values.

<table>
<thead>
<tr>
<th>AC</th>
<th>Cwmin (CWmin+1)/2-1</th>
<th>Cwmin</th>
<th>Cwmax</th>
<th>AIFSN</th>
<th>TXOP FHSS</th>
<th>Limit DSSS</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC_BK</td>
<td>Cwmin</td>
<td>Cwmax</td>
<td>7</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>AC_BE</td>
<td>Cwmin</td>
<td>Cwmax</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>AC_VI</td>
<td>(CWmin+1)/2-1</td>
<td>Cwmin</td>
<td>2</td>
<td>6.016ms</td>
<td>3.008ms</td>
<td></td>
</tr>
</tbody>
</table>

The Literature Review

Veres et al. [1] proposed estimation of the available bandwidth at a node based on passive listening of the wireless medium. A Virtual MAC (VMAC) algorithm is used to emulate MAC layer operations in real time. A virtual MAC layer passively monitors the radio channel and estimates locally achievable service levels. The VMAC estimates key MAC level statistics related to a quality of services such as delay, delay variation, packet collision, and packet loss. A drawback of this solution is its overhead in resources such as CPU time and battery.

Campbell et al. [2] proposed a stateless network SWAN model, which uses distributed control algorithms to deliver service differentiation in mobile wireless ad hoc networks in a scalable manner, robust and simple. A novel aspect of SWAN is that it does not require the support of a QoS capable MAC. The proposed model shows performance evaluation of SWAN using the ns-2 simulator, analyze the busy probabilities and the MAC delay. Simulation, analysis, and results from experimental wireless testbed showed that there are low and stable delays in real time applications, under various multi-hop, traffic and mobility conditions.

Ge et al. [3] proposed QoS versions of the OLSR (Optimized Link State Routing) protocol, which is a proactive, Ad-Hoc routing protocol. The introduced heuristics that allow OLSR to find the maximum bandwidth path, show through simulation and evidence that these heuristics do improve OLSR in the bandwidth QoS aspect. The analyzed performance of the QoS routing protocols in OPNET network simulator, observe the achievement obtained, and the cost paid. The simulation results show that the OLSR routing protocol’s QoS versions do improve the available bandwidth of the routes computed, but the added cost, also, has There is a negative impact of the additional overhead on the network in Packet Delivery Ratio and End-to-End Delay, especially in the high-speed movement scenarios.

Damrouy and Elsakankiri [4] suggested that AODV protocol is augmented to ensure QoS and load balancing. Extensions are added to the message in route discovery. The performance of both AODV and QoS-AODV protocols is studied with packet layer simulated model. Main performance measures like packets normalized routing load, average delay, and the delivery fraction was compared. Simulated were undertaken with the network of 50 mobile nodes, varying network loads, delay constraints, topological change rate and mobility speeds. Results prove improvements over existing AODV protocols.

Lei Chen and Wendi B. Heinzelman [5] proposed a feedback scheme to meet the QoS requirements of real-time applications and a QoS-aware routing protocol that incorporates an admission control scheme. The novel part of this QoS-aware routing protocol to the use the approximate bandwidth estimation to respond in response to network traffic. This approach implements these schemes by using two bandwidth estimation methods to find the remaining bandwidth available at each node to support new streams. This model simulates the QoS-aware routing protocol for nodes running the IEEE 802.11 MAC. Results of experiments show that the
packet delay and energy dissipation decrease and packet delivery ratio increases greatly significantly, while the overall end-to-end throughput is not impacted. As compared with routing protocols that do not provide QoS support.

Mammeri and Espes. [6] presented an AODV based QoS routing algorithm which spreads traffic flow over global topology, by increasing throughput and decreasing packets colliding over paths. More metrics long with hops used by AODV protocol was introduced. Most routing algorithms use one or two metrics for path location. The proposed method provides a weight function through the use of many parameters. To show the proposed protocol’s efficiency, simulations were presented with NS2.

Enzai et al [7] proposed an enhanced AODV to improve QoS. AODV including maximum delay extension or minimum bandwidth extension. The work highlights combining both metrics: delay and bandwidth. This method’s effectiveness was evaluated with the NS-2 simulator. Simulator study used various scenarios and differing mobility parameters like Average latency, PDR and normalized overhead load. Experiments studied the effect of many mobile nodes, maximum node speed, and traffic load and also connectivity maintenance method’s on HELLO messages and MAC layer feedback.

Xiaolin Cheng et al. [8] proposed a MARIA scheme to support QoS for multimedia applications. A conflict graph model is used to capture both inter- and intra-flow interference. The residual bandwidth available is computed based on the maximal clique constraints in its local conflict graph to make distributed hop-by-hop admission control decision. Simulation results show that with admission control and QoS routing support, MARIA outperforms the conventional protocol. The proposed scheme discovers routes with less interference and enables better network utilization and high-quality video delivery. This scheme assumed a distance based model with fixed channel capacity for its simplicity and ease of implementation. It is, however, not limited to this assumption. Dynamic capacity can be plugged into the conflict graph model.

M. Chuah and W. Chen [9] designed a cooperative multichannel MAC (COMMAC) where nodes include channel usage information they collect in the RTS/CTS packets they transmit and send special control packets to help other nodes avoid unnecessary bakeoffs. The channel usage information includes the channels that primary users are using. Through simulations, we show that our COMMAC scheme can provide a throughput gain of 35% compared to that can be achieved using the AMCP scheme.

Bibhash et al. [10] suggested new route maintenance process, with multiple options to improve performance during route link failure. Delay and bandwidth, two QoS parameters are considered for route discovery reply. During route discovery, chosen routes had a minimum delay and high bandwidth. Route maintenance procedures are applied to routes independently and by internal nodes simultaneously during link failure.

Jairath and Khan [11] proposed a sub-layer called Modified AODV (ad-hoc on demand distance vector) provide a bidirectional abstraction of the unidirectional network to the routing protocols. This presents a scalable and efficient way to provide this abstraction by maintaining and finding multi-hop reverse routes to each unidirectional link. This simulates to route packets and modified AODV in the unidirectional network. It is observed that with modified AODV, the packet delivery of AODV in unidirectional networks increases substantially. Further simulations of proposed network indicate that reverse routes are often only a few hops long and in this way the overhead of using modified AODV is very low.

Balasubramanie and premalatha [12] Presented the under look performance evaluation combining network layer and MAC layer protocols with transport layer congestion control mechanisms in a MANET. MAC problems and disconnection due to mobility, in ad hoc networks, lead to network layer being unable to detect path for packet delivery. Thus, QoS parameters like error rate, delay, and packet loss increase and throughput and delivery ratio decrease in Transport layer. Mechanisms of three layers are combined to improve QoS drastically. Two different MAC protocols effects- IEEE 802.11 and
IEEE802.11e with AODV and DSR of routing algorithms was observed. The impact of multiple wireless hops/node mobility on Transmission Control Protocol’s(TCP) throughput performance on each MAC protocol with two routing algorithms is accessed. Other QoS parameters like delay, bandwidth delay product, delivery ratio, and packet loss investigated revealed improved QoS parameters. Results improved in QoS parameters; 35-40%, 25-30%, improvement in throughput, bandwidth delay respectively, 15-20% in delivery ratio, 20-25% packet loss being reduced drastically to in IEEE802.11e with AODV algorithm in network layer.

Increase Multiplicative Decrease (AIMD) mechanism in the transport layer. Substitution of DSR for AODV affects QoS parameters. But packet loss is higher in DSR algorithm which affects PDR and throughput. This scenario was analyzed and suitable mechanisms were suggested in all layers for enhancement of QoS parameters.

Dvir et al. [13] proposed an alternative, backpressure routing scheme for Delay Tolerant Networks (DTN), in which routing and forwarding decisions are made on a per-packet basis. Techniques such as queue backlogs, random walk and data packet scheduling incorporated in the nodes that can make packet routing and forwarding decisions without the notion of end-to-end routes. Integrating the backpressure approach with weighted fair queuing (WFQ) and packet reception rate (PRR) approaches improves the efficiency of the energy consumption but it decreases the packet delivery ratio.

Zafar et al. [14] proposed a new capacity-constrained QoS-aware routing scheme referred a shortest multipath source (QSMS) routing which allows the node to obtain and then use an estimation of the residual capacity to make appropriate admission control decisions. In the QSMS scheme, there is no provisioning of any predictive way to anticipate a route break, which causes performance degradation, particularly in mobile scenarios.

Heni KAANICHE et al. [15] proposed an approach to estimate available resources on a node. This approach is based on the estimation of the busy ratio of the shared canal. In this estimation the several constraints related to the Ad hoc transmission mode such as Interference phenomena. This approach is implemented in the AODV routing protocol. AODV with QoS is new routing protocol formed. Performance evaluations are performed by simulations using NS2 simulator. The results confirm that AODV with QoS provides QoS support in ad hoc wireless networks with good performance and low overhead. By simulations, it shows that this technique provides an accurate estimation of the available bandwidth on wireless links in many ad hoc configurations. It also showed that PDR assured by AODV with QoS is better than that of AODV.

Yuwei Xu et al. [16] proposed an admission control protocol, employing local analytical utilization estimation and a two-round signaling process for admission and route establishments. The simulations demonstrate that the proposed admission control mechanism can effectively avoid congestion and provide adequate QoS for video streaming over MWNs. New admission control mechanism is ACE-AC mechanism. ACE-AC is able to maintain the video quality at the desired level. The performance of ACE-AC in simulation indicates that ACE-AC can detect the potential congestion and reduce the risk of the impaired video experience. In MARIA a node accepts a new video stream if it satisfies the bandwidth condition that the node and all its neighbor nodes transmission bandwidths are smaller than a theoretical bandwidth threshold. As MARIA needs to use HELLO messages to exchange information, which could cause further network congestion. On the other hand, extended range transmission is used in MARIA to eliminate the hidden node problem.

Hosek et al. [17] described that the characteristics of MANET and QoS issues present in the network. The work has been focused mainly on the AODV routing protocol and its ability to provide different processing probabilities for the different type of network traffic. The development of the MANET simulation model and implementation of AODV protocol were described. The Network Simulator 3 was used as the key software too. The analysis of the efficiency of QoS mechanism implemented into AODV protocol and final evaluation was posted. Quispe et al. [18] described throughput performance in MANET and compared emulated test bed results.
with simulated results from NS2. The performance of the MANET was very sensitive to the number of users. When the number of user load was high then the collisions increase results in larger wastage of the medium overall throughput. To compare the throughput of MANET using three different scenarios: 97, 100 and 120 nodes using simulator NS2. By analyzing the graph in MANETs, it was observed that when the number of nodes has been increased beyond the certain limit then the throughput decreases.

Surjeet et al. [19] proposed a novel on-demand QoS routing protocol (MQAODV) for bandwidth constrained delay sensitive applications in MANETs. It discovers routes based on bandwidth constrained path delay in addition to the hop count. QoS is not guaranteed in case of route break or network partition, so this approach does not suit well for mobile topologies. The link failure prediction strategy is also not incorporated in this scheme.

Li et al. [20] proposed a reliable multicast protocol Code Pipebearing characteristics of energy-efficient, high throughput and fairness in lossy wireless networks. CodePipe facilitates coordination between nodes, as well as improve the multicast throughput significantly by exploiting both Intra batch and interbatch coding opportunities. Four key techniques namely, LP-based opportunistic routing structure, opportunistic feeding, fast batch moving and interbatch coding are employed to achieve the mentioned characteristics.

Prakash Srivastava and Rakesh Kumar [21] proposed a QOS enabled route discovery procedure which involves estimation of node bandwidth and delay at every node. In addition to this, an efficient link failure strategy is also included by estimating link expiration metric with the help of signal intensity level to provide prediction before route break up. This protocol fulfills the stringent real-time requirements of delay and bandwidth.

REFERENCES


