1. INTRODUCTION:

It is well known fact that packet loss is big problem in networks, in this chapter we analyze the importance and cause of packet loss in networks, this packet loss caused by buffer overflow in intermediate network nodes. Packet loss causes performance degradation. The buffer overflow is controlled by setting a threshold value which is equal to the buffer size of the node. If the threshold limit is reached, rate of flow of packets is reduced to reduce packet loss. The Overflow of link is controlled by setting a threshold value which is equal to the link capacity between the nodes. If the threshold limit is reached, packet loss is decreased by reducing the rate of flow of packets. The simulation results show that packet loss in link and buffer is reduced significantly after introducing threshold mechanism. We illustrate our approach with examples.

Wireless networks are used widely for a variety of applications such as environment sensing, health care, manufacturing industry, and transportation industry. However, packet loss is one of the important criteria which need to be controlled to achieve the required performance of the wireless networks. If packet loss is not controlled then there will be a decrease in the performance of wireless networks. The reasons for the packet losses in wireless networks should be identified first and then only, it can be reduced. Packet loss may occur in the buffer of a node, if the size of the buffer [1] becomes less than the flow of packets into the buffer. Packet loss occurs in the wireless link between two nodes, if the link capacity [2] becomes less than the rate of flow of packets.

The loss of packet in the buffer and the wireless link can be reduced by setting the threshold limit and if it is reached then the rate of flow of packets should be reduced. The threshold set for the buffer is the buffer size. The packets are made to flow between nodes until the threshold limit is reached. The threshold limit is reached or not can be identified by continuously comparing the threshold value with the amount of packets accumulated in the buffer. The packet flow is continued until the
threshold limit is less than or equal to the amount of packets in the buffer. When the packets in the buffer exceeds the threshold limit then the flow is slowed down. The packet loss due to buffer overflow is reduced to a large extent after introducing threshold when compared to the scenario of packet loss due to buffer overflow before introducing threshold.

The threshold for the link is the link capacity. Link capacity is the total number of bytes flow through the link measured in kilobytes per second. The flow of packets through the wireless links between the nodes is continued until the threshold limit is reached. The rate of flow of packets is compared regularly with the threshold. The rate of flow of packets reduced when it exceeds the threshold. The loss of packet is greatly reduced after applying threshold when compared to the packet loss before applying threshold in the link.

2. BASIC DEFINITIONS:

2.1 Wireless Networks:

A wireless network, which uses high-frequency radio waves rather than wires to communicate between nodes, is another option for home or business networking. Individuals and organizations can use this option to expand their existing wired network or to go completely wireless. Wireless allows for devices to be shared without networking cable which increases mobility but decreases range.

There are two main types of wireless networking:

- Peer to peer or ad-hoc
- Infrastructure. (Wi-fi.com)

2.1.1. Ad-hoc or peer-to-peer wireless network:

An ad-hoc or peer-to-peer wireless network consists of a number of computers each equipped with a wireless networking interface card. Each computer can communicate directly with all of the other wireless enabled computers. They can share files and
printers this way, but may not be able to access wired LAN resources, unless one of
the computers acts as a bridge to the wired LAN using special software.

2.1.2. Infrastructure wireless network:

An infrastructure wireless network consists of an access point or a base
station. In this type of network the access point acts like a hub, providing
connectivity for the wireless computers. It can connect or bridge the wireless LAN to
a wired LAN, allowing wireless computer access to LAN resources, such as file
servers or existing Internet Connectivity.

There are four basic types of transmissions standards for wireless networking. These
types are produced by the Institute of Electrical and Electronic Engineers (IEEE).
These standards define all aspects of radio frequency wireless networking. They have
established four transmission standards; 802.11, 802.11a, 802.11b, 802.11g.

The basic differences between these four types are connection speed and radio
frequency. 802.11 and 802.11b are the slowest at 1 or 2 Mbps and 5.5 and 11Mbps
respectively. They both operate off of the 2.4 GHz radio frequency. 802.11a operates
off of a 5 GHz frequency and can transmit up to 54 Mbps and the 802.11g operates
off of the 2.4 GHz frequency and can transmit up to 54 Mbps. Actual transmission
speeds vary depending on such factors as the number and size of the physical barriers
within the network and any interference in the radio transmissions. (Wi-fi.com)

Wireless networks are reliable, but when interfered with it can reduce the
range and the quality of the signal. Interference can be caused by other devices
operating on the same radio frequency and it is very hard to control the addition of

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new devices on the same frequency. Usually if your wireless range is compromised considerably, more than likely, interference is to blame. (Laudon).

A major cause of interference with any radio signals are the materials in your surroundings, especially metallic substances, which have a tendency to reflect radio signals. Needless to say, the potential sources of metal around a home are numerous—things like metal studs, nails, building insulation with a foil backing and even lead paint can all possibly reduce the quality of the wireless radio signal. Materials with a high density, like concrete, tend to be harder for radio signals to penetrate, absorbing more of the energy. Other devices utilizing the same frequency can also result in interference with your wireless. For example, the 2.4GHz frequency used by 802.11b-based wireless products to communicate with each other. Wireless devices don't have this frequency all to themselves. In a business environment, other devices that use the 2.4GHz band include microwave ovens and certain cordless phones. (Laundon).

3. RELATED WORK:

Describes the Long term Evolution (LTE) network. LTE network is the next-generation network technology beyond 3G. When dealing with the traffic bursts in wireless due to environmental interferences, buffer overflow occurs often in the evolved Node B (eNB) of the LTE network. When the buffer becomes congested, to protect the buffer from overflow the advertisement window is approximately controlled in order to enhance Transmission Control Protocol (TCP). The data sending rate will be slowed down by the sender upon the receipt of reduced advertisement window, and hence the buffer overflow becomes alleviated. The end to end system performance in terms of network throughput enhanced, average packet delay and jitter, as well as rate of packet loss reduced [3].

Consider a network merging streams of packets with different quality of service (QoS) levels, where packets are transmitted from input links to output links via multiple merge stages. Overflow occurs when the sum of incoming bandwidths is larger than the bandwidth of a outgoing link from a merge node. A positive value is
assigned to each packet by QoS and the goal of the system is to maximize the total value of packets transmitted on the output links thus reducing the buffer overflow and the weakness of a link which is defined as the ration between the longest time a packet spends in the system before being transmitted over the link, and the longest time a packet spends in that link's buffer [4].

![Diagram of Packet Transmissions between Sender and Receiver]

**Fig: 5.1 Packet Transmissions between Sender and Receiver**

Proposes a buffer overflow notification protocol, to control overflow of buffer effectively at the link layer in the wireless adhoc networks. The higher transmission priority is allowed to the congested node by the protocol so as to access a shared medium by the dynamic adjustment of the contention window of the node at its neighboring node. Simulation results show that 10-20% improvement of throughput is achieved by the buffer overflow notification protocol. The packet loss due to buffer overflow is immediately and efficiently reduced in intermediate nodes on the transmission path[5].

Present a new link capacity estimation metric named as Effective Link Capacity (ELC). Link capacity is estimated with the help of information such as the transmission count of data packets (TXC) and the packet delivery ratio (PDR). Since ELC uses only the locally available information from the transmitting node, overhead incurred is zero. ELC's accuracy on single link as well as on the hidden terminals is evaluated with different configurations of packet sizes, link rates and offered loads. ELC also compared with other bandwidth estimation tools. In all the cases ELC is proved to be more accurate[6].
Describes the conversion of signal strength percentage to dBm values. Energy is measured in milliwatts (mW). The —dBm (dB-milliwatt) is a logarithmic measurement of signal strength, and dBm values can be exactly and directly converted to and from mW values. Therefore dBm can be obtained using the expression dBm = log(mW) * 10. The Receive Signal Strength Indicator (RSSI) is an integer with an allowable range of 0-255 (a 1-byte value). Clear Channel Threshold is used to find out whether the channel is free. If the RSSI value falls below a certain range then it is the indication that the channel is free and not used by anybody to transmit data. For CISCO the dBm values varies from -113 to -10 corresponding to the variation in the RSSI value from 0 to 100. The packet loss occurs in buffer as well as in link in wireless nodes. It is essential to reduce the packet loss to improve the network performance. The packet loss is reduced in buffer by slow down of packet transmission if the flow of packets exceeds maximum buffer size. The packet loss in link is reduced by slow down of transmission of packets if the link utilization exceeds link capacity [7].

4. ANALYSIS ON PACKET LOSS:

4.1. Packet Loss in buffer due to buffer overflow:
Packet Loss in buffer due to buffer overflow Buffer overflow occurs due to the shortage of space in the buffer to store the packets which leads to packet loss. If the flow of packets is greater than the size of the buffer then there is a packet loss. The amount of packet loss is taken into account and the transmission of packet continues. Since there is no threshold mechanism for buffer size to control the packet loss, the packet loss increases.

4.2 Packet loss in link due to link capacity overflow:
Link capacity overflow occurs when the rate of flow of packets is higher than the link capacity [viii]. There will be packet loss when there is a link capacity overflow. Rate of flow of packets while passing through the wireless link between the nodes are calculated. The link capacity in the wireless link depends upon the signal strength available. The link capacity varies with the variation in the received signal strength of a node. The Link capacity can be calculated as

\[
\text{Link capacity} = \text{Link utilization} + \text{Available link space}
\]
The Link utilization \[ix\] is the part of the link being utilized by the node during packet transmission. Available Link space or free link space is the part of the link which is empty or not being utilized by the node during transmission of packet. Packet loss will continue to occur if the link utilization or the rate of flow of packets exceeds the link capacity making link space unavailable. Since there is no threshold mechanism for link to control packet loss, the packet loss increases.

5. PROPOSED SYSTEM:
5.1 Reducing Packet loss in buffer due to buffer overflow

Reducing Packet loss in link due to link capacity overflow can be reduced by introducing the threshold mechanism. The threshold value set for reducing packet loss in buffer is Buf-threshold. The maximum size of the buffer (Buf-max) is assigned as the Buf-threshold. When the number of packets in the buffer (Buf-used) exceeds the threshold then slow down the flow of packets, thus reduces the packet loss.

5.1.1. Algorithm 1: Reducing packet loss in buffer due to buffer overflow

Set maximum buffer size (Buf-max) to 20 packets
Set Buf-threshold to Buf-max
Measure the number of packets in the buffer (Buf-used)
if (Buf-threshold>Buf-used)
store the packets in the buffer and continue the transmission of packet
else
slow down the transmission of packet
end if

5.2 Reducing Packet loss in link due to link capacity overflow:

The packet loss in the wireless link is reduced by applying threshold. The threshold value set for reducing packet loss in link [10] is Link-threshold. The maximum capacity of the link (Link-max) is assigned to the Link-threshold. Link utilization is the measure of number of packets flow through link (Link-used).
5.2.2. Algorithm 2: Reducing packet loss in link due to link capacity overflow

Measure the received signal strength

set the maximum link capacity (link-max) based on the received signal strength
(for example the signal strength from -12 dBm to -92 dBm is set to link capacity of 1 kbps (link-max))
Therefore higher the signal strength then higher the link-max
set link-threshold to link-max
measure the link utilization (link-used)
if link-threshold>link-used
Continue the transmission of packet else
slow down the transmission of packet
end if
Go to step 1

If the signal strength is zero then the wireless link between the nodes is unavailable. Since the link is not present between the nodes, transmission of packets between them is not possible. It is assumed that if the signal strength varies from 1 to 5 then the value of Link-max varies from 1 kbps to 5 kbps. If Link-used exceeds the Link-threshold then slow down the transmission of packets to reduce packet loss.

6. EXPERIMENTAL SETUP:

The experiment is conducted in java environment

Multiple threads are created. Each threads are made to act as separate nodes. The packets are made to flow between these nodes. Simulation is made to run for different time intervals and the amount of loss of packets are measured.
7. PERFORMANCE ANALYSIS:

7.1 Packet Loss in buffer due to buffer overflow:

Fig.5.3 Packet loss due to buffer overflow.

Fig.3 shows the packet loss due to the buffer overflow without the threshold mechanism. It reveals that the packet loss increases when the simulation time increases.
7.2 Reducing packet loss in buffer due to buffer overflow:

![Graph showing packet loss in bytes over time in milliseconds]

Fig. 5.4 shows the packet loss due to the buffer overflow with the threshold mechanism. It reveals that the packet loss decreases when the simulation time increases.

7.3 Packet loss in link due to link capacity overflow:

Packet loss due to link capacity overflow without the threshold mechanism. It reveals that the packet loss increases rapidly with the decrease in signal strength.
Fig. 5.5 Packet loss due to link capacity overflow. Reducing Packet loss in link due to link capacity overflow:

Fig. 5.6 shows the packet loss due to link capacity overflow with the threshold mechanism. It reveals that the packet loss decreases with the increase in signal strength.

8. CONCLUSION:

In this chapter presented a threshold mechanism that reduces the packet loss in the buffer and the link of wireless network. The packet loss in the buffer of a node is due to the overflow of buffer. The packet loss in link between the nodes is due to the overflow of link capacity. Both the buffer overflow and link capacity overflow is determined and controlled with the help of threshold mechanism. The rate of flow of packets is reduced as soon as the overflow occurs i.e. threshold is reached and packet loss is reduced.
REFERENCES:


