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Designing and Performance Evaluation of Low Bit Rate Audio Streaming Over Wireless Personal Area Network

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Abstract: ***The IEEE 802.15.4 is a Personal Area Network well-known designed for programs like wireless monitoring and control of lights, protection alarms, movement sensors, thermostats and smoke detectors. IEEE 802.15.4 specifies bodily and media access manages layers that have been optimized to make certain low strength consumption. For the conversation among two nodes, best throughput for IEEE 802.15.4 is 250 kbps on a 2.4GHz band. However, because of header overhead, the done throughput is much less than 250 kbps. Also, the range of nodes taking element in a conversation has a substantial impact on throughput. The best bit rate for Zigbee/IEEE 802.15.4 is 250 kbps for the 2.4GHz band. The bit rate of 250 Kbit/s consistent with the channel and cannot be fully used for the payload (audio records). There is an overhead associated with the manner that the conversation works. Numerous mechanisms have to be taken into account while estimating the powerful transmission rate. ZigBee has a layer shape, and every layer adds additional header statistics, in order that the payload at the quit is less than the quantity of information this is sent. The overall amount of more bytes relies upon at the layer from which the utility runs, and on the operating mode of the verbal exchange machine. The principle goal is to calculate maximum throughput for audio streaming the usage of IEEE 802.15.4 for 10 different nodes. IEEE 802.15.4 defines specific layers but right here, we do not forget the Physical layer (PHY) and Medium Access manage (MAC) sublayer.***

Keywords: ***IEEE 802.15.4, Media Access Control, Zigbee, Audio Data, Medium Access Control (MAC).***

I.INTRODUCTION

ZigBee is an open worldwide fashionable providing Wi-Fi networking based totally on the IEEE 802.15.4 general and taking full gain of an effective physical radio this standard specifies. ZigBee is the end result of collaborative efforts with the aid of a global consortium of companies called the ZigBee Alliance. ZigBee and the underlying protocol IEEE 802.15.4 have been advanced with a low information rate in thoughts. Low power consumption is ordinarily observed for programs wherein the information rate is low, and devices can frequently move in power down mode. There are numerous arguments that communicate in favour of a ZigBee technique to be considered for audio records, at the least for a certain class of audio packages: – The statistics price necessities wished for audio greatly varies with the software, and will variety among tens of Kbps (low-exceptional speech) and masses of Kbps (superb music best), making ZigBee an opportunity to recall for low-stop / mid-give up applications. Compression techniques that are currently been used within the telephone (speech) or music industries could be implemented to lessen the facts rate. This may, of direction, require using appropriate processing power for compression/decompression algorithms. Many algorithms with diverse ranges of complexity are available, with bit price been reduced insure instances down to 3 Kbit/s. a few applications already combine the necessary computing strength or even the necessary compression algorithms. ZigBee / IEEE 802.15.4 modems have a low complexity, making it less difficult for the application engineers to integrate them into an answer. The ability low value of ZigBee / IEEE 802.15.4 modems makes it probable that they may be deployed in big quantities, and the number of packages the use of this well known will increase. As this quantity grows, its miles inevitable that for programs that already combine a ZigBee modem and where the audio verbal exchange is wanted; one will bear in mind the opportunity of the use of that modem for audio. The network capacities of ZigBee are really worth thinking about for low-stop audio packages that need to cover small vicinity, and ought to have the power and ease of deployment furnished through a wi-fi machine. The routing competencies of ZigBee can be utilized in a comparable way to VoIP systems.

ZigBee

ZigBee is an open global preferred imparting wireless networking primarily based on the IEEE 802.15.4 fashionable and taking full gain of a powerful bodily radio this fashionable specifies. ZigBee is the result of collaborative efforts with the aid of a worldwide consortium of companies known as the ZigBee Alliance. ZigBee includes the subsequent key functions:

• Low price,

• Lengthy battery lifestyles (months to years).

• accommodate massive sensor nodes (Max. 65,535)

• provides high protection the use of 128 bits AES

• Excessive reliability

ZigBee Alliance has advanced

• Very low value

• Very low strength consumption

• Two-way Wi-Fi verbal exchange preferred

ZigBee is called after HoneyBee which uses a zigzag type of dance to communicate statistics like food to other hive participants. through dancing in a zig-zag sample, the bee is able to percentage vital records, such as the place, distance, and course of a newly observed meals source to its fellow hive members. 2.1.1. ZigBee Topology

Topology

- Celebrity
- Cluster Tree: minimal routing overhead uses multi-hop routing
- Mesh: Mesh network lets in any node to transmit to any other node in the network within radio transmission range

A. Types of Devices

Coordinator: All ZigBee networks must have only one Coordinator, irrespective of the network topology.

Routers: The task of Routers are to relay messages from one node to another, allow child nodes to connect to it, and talk to the coordinator, to other routers, and to reduced-function end devices (RFD)

End- devices: The main task of an End-device at the network level is sending and receiving messages.

B. States of Operation

Active

Sleep

C. Nodes

Full Function Devices (FFD): Coordinator, Router

Reduced Function Devices (RFD): End device

D. Modes of operation

Beacon

Non-beacon

I. SIMULATIONS, RESULTS and PERFORMANCE EVALUATION

The evaluation is being accomplished on the idea of the consequences of the *.nam record and the *.tr record. Within the ns2-allinone bundle, NAM is a built-in program. NAM facilitates us to peer the float of message among the nodes. It additionally indicates the packets are dropping or attaining to the vacation spot properly. While the TCL record is written, NAM has invoked internally that file. With the assist of 2d graphs, we've got attempted to analyze the simulation with a special range of nodes. The scripts for the NAM is stored as *.nam and for hint graph *.tr is used. The simulation has been specifically divided into elements which might be given underneath:

• Simulation of single-hop transmission

- Simulation of 3-hop transmission under extraordinary situations

The throughput of all of the instances is evaluated. The contrast of throughput for an extraordinarily wide variety of nodes is also completed.

A. Simulation of Single-Hop Transmission

Simulation of unmarried-hop transmission has executed the usage of 2 nodes the placement of the nodes is fixed. Each is separated with the aid of a distance of 25 meters. Node zero is labeled as PAN Coordinator and the node is labeled as a full-functional tool. The simulation time is taken as 90 seconds. Node 1 begins to constructs a regular bit fee (CBR) traffic float to node zero at a time of 30 seconds. CBR visitors in NS-2 calls for two parameters, packet size, and packet price. The dimensions of the packet are taken as 116 bytes (101 bytes payload and 15 bytes of Zigbee header). The packet charge set for simulation is a single packet each 3.0 milliseconds, much less than 1/2 of the anticipated 7.0 milliseconds required for entire transmission. This may be proven as in figure 1 below

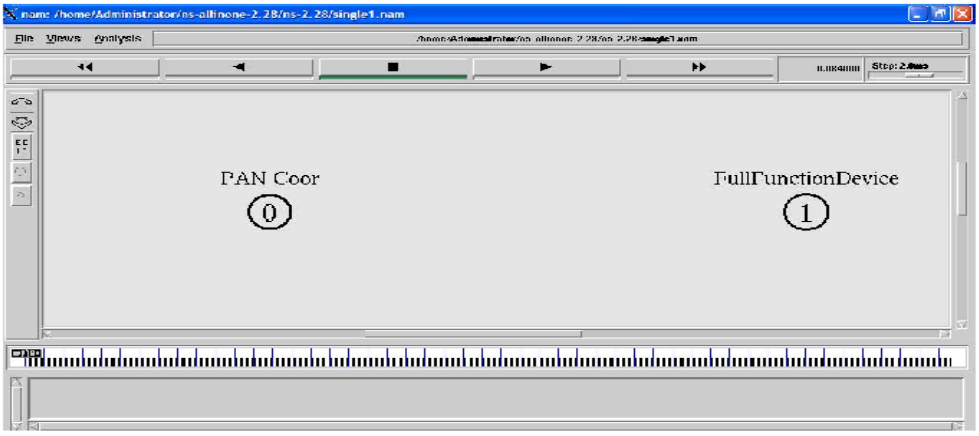

Figure 1- Two nodes labeled as PAN Coor and Full Function Device at simulation time=0 seconds

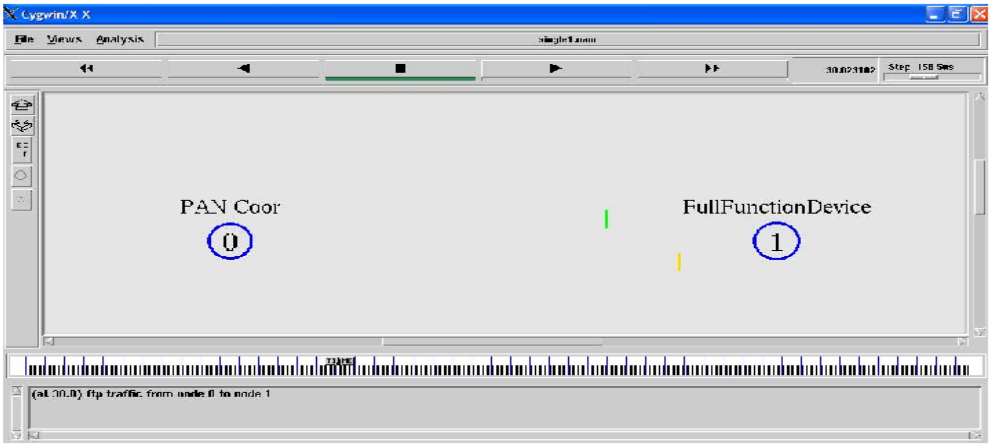

Figure 2- Two nodes transmitting data at simulation time=30 seconds
In figure 2, the green colour packet indicates transmitted data and the yellow colored packet is the acknowledgment packet.

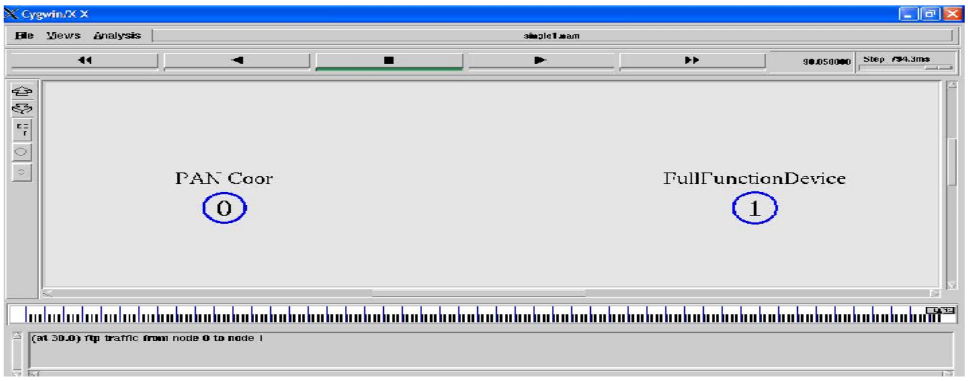

Figure 3- Nodes stop transmitting data at simulation time=90 seconds

The trace graph snapshots have been taken with the simulation time of 90 seconds. In figure 4, the entire simulation scenario has been displayed

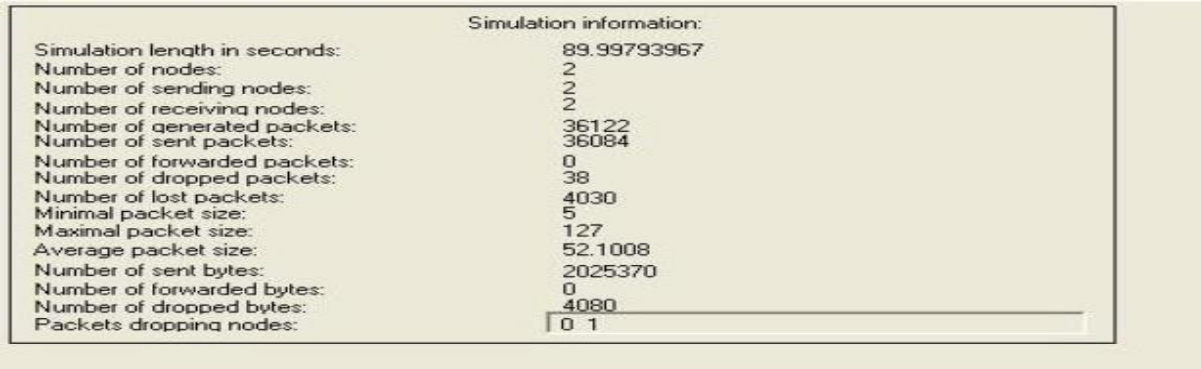

Figure 4- Simulation Details

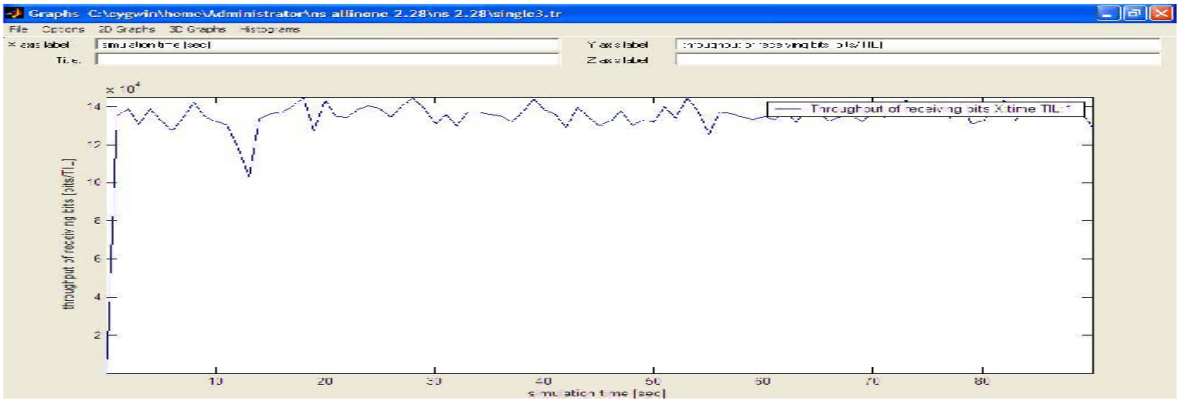

Figure 5- Throughput of receiving bits versus simulation time

The throughput of receiving bits is acquired as 130kbps. right here the simulation time is taken as 90 seconds that is because when we take a small price (much less than 10 seconds) of the simulation time proper hint graph isn't always received i.e. there might simplest be a few peaks, not a right wave this could lead to misinterpretation of end result (every now and then there may be a large delay at the same time as transmitting statistics. If we have taken much less simulation time there is probably the possibility that the information transmission takes place after that simulation time and we achieve no end result.).
The result can be better interpreted whilst simulation time is taken huge (about greater than one thousand seconds). but due to the fact, the growth in the simulation time results in the era of a very big track record and it'll take a huge amount of time to load the hint record within the device hint graph 2.02. Subsequently to avoid such conditions we take a reasonable simulation time.
The drop within the graph is because of the disassociation of node and/or packet drops. Sometimes we are able to see that there may be sure fall inside the wide variety of packets obtained due to the disassociation of nodes, collision among facts at a single node which leads to packet drop.

B. *Simulation of 3-hop Transmission*

As we have already seen in section 3.3 that an upper bound on multi-hop throughput when all nodes in a n-hop route interfere with each other is

$$T_m(n) = \frac{1}{n} \times T_s$$

where Tm(n) is measured in kbit/s.

In this scenario only 4 nodes i. e. 3-hops are active at a time. So the throughput for 4 nodes is given as

Tm (4) = 1 * Tm(1) = 40 kbps 3

Figure 6 shows the simulation of 4 nodes i.e 3-hop transmission. The simulation time is taken as 100 seconds. Node 0 is labeled as PAN Coordinator.

Figure 6- Data Transmission between 4 nodes

The throughput can be obtained by trace graph. This can be shown as

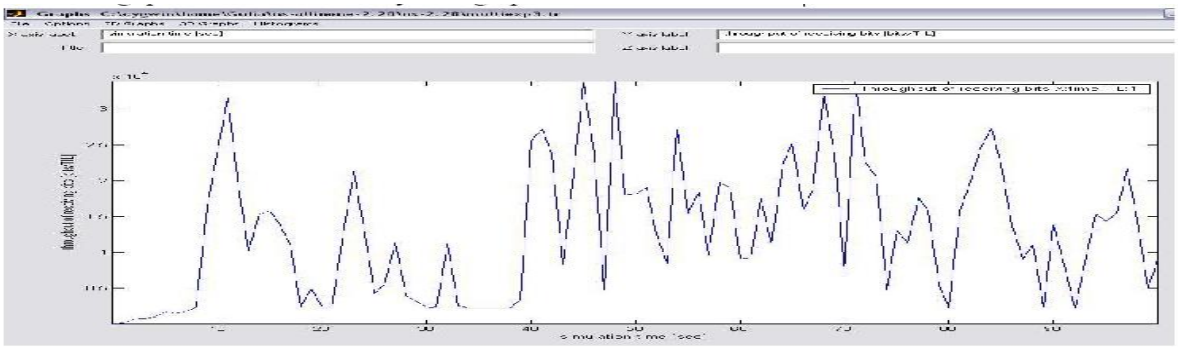

Figure 7 – Throughput of Receiving Bits versus simulation time

Throughput for 4 nodes i.e. three-hop transmission is 30 kbps. This value is about 1/3 of the throughput of single-hop transmission. Throughput for four nodes i.e. 3-hop transmission is 30 kbps. This cost is approximately 1/3 of the throughput of unmarried-hop transmission and the accomplished cost is 30 kbps about. The peaks display the information transmission while nodes are in association with PAN coordinator and no packets are dropped. The unexpected fall inside the graph suggests packets losing and/or node(s) getting dissociated from PAN coordinator. we've completed the simulation whilst there are eight nodes. The nodes are transmitting as 2 sets of four nodes each transmitting as 3-hop transmission. In this situation, when most effective nodes four, five, 6, and seven (in which node 4 is classified as PAN Coordinator) are inactive state and nodes zero to 3 are inactive then we received the throughput as 30 kbps. The simulation time, in this situation, is also 100 seconds.

Throughput for 8 nodes, while used as a hard and fast of two 3-hop transmissions (node 0 to node three, node four to node7) if all of the sets are transmitting simultaneously, is about 30kbps. This value is identified as that of a single three-hop transmission.

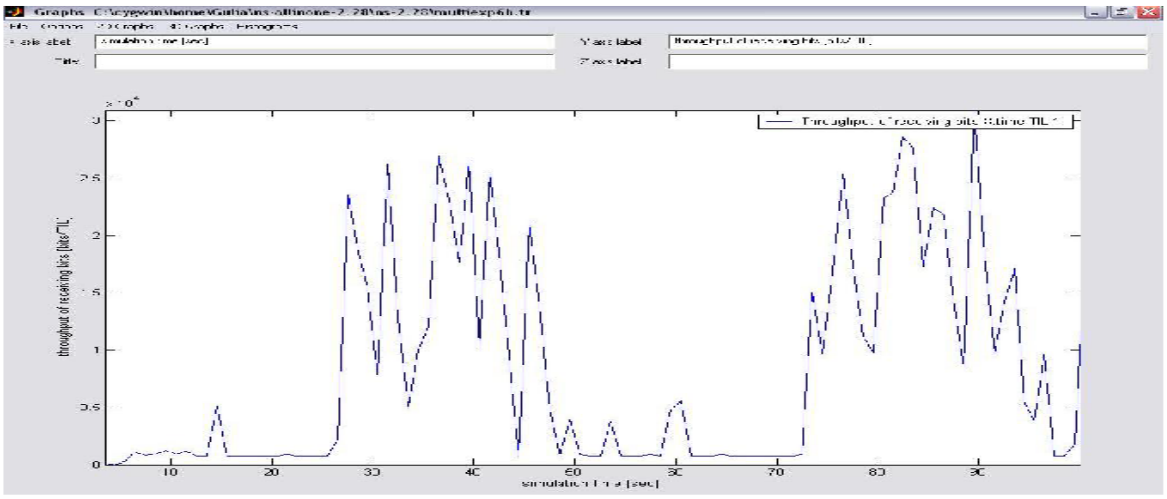

Figure 8 Throughput of Receiving Bits versus Simulation Time for 8 nodes in sets of 4 nodes each set independent of transmission range of another set

We've finished the simulation while there are 12 nodes. The nodes are transmitting as 3 sets of 4 nodes each transmitting as 3-hop transmission. In this example, while simplest nodes 8, nine, 10, and 11 (in which node 8 is categorized as PAN Coordinator) are in lively kingdom and nodes zero to 3 & nodes four to 7 are inactive then we received the throughput as 30 kbps. The simulation time in this example is likewise one hundred seconds.

We've additionally carried out the simulation whilst all three units of nodes i.e. 0-three, four-7 and 8-11 are transmitting the result obtained can be shown underneath. here nodes 0, four and eight are PAN Coordinators. The simulation time in this example is likewise 100 seconds.

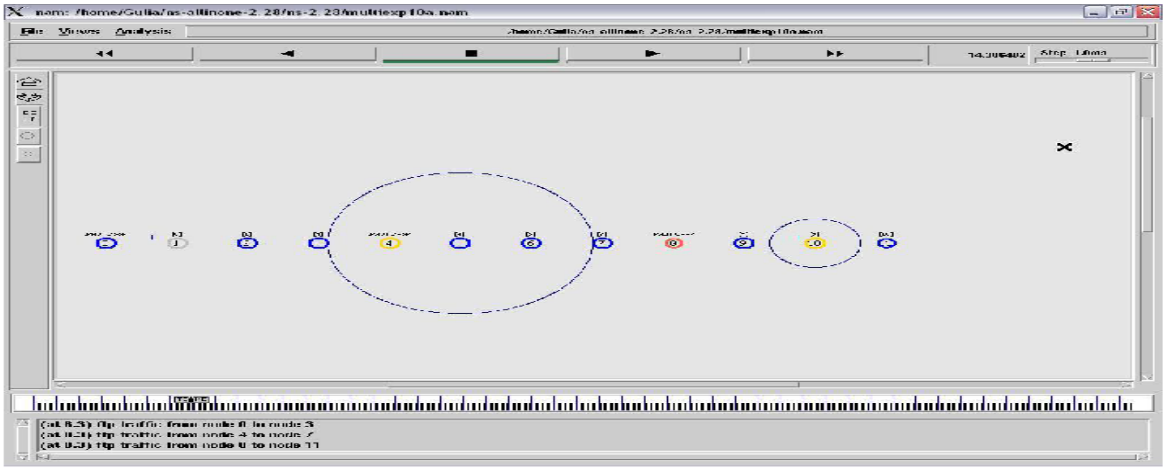

Figure 9 - Data Transmission between Nodes 0-3, nodes 4-7 and nodes 8-11
The trace graph for this case is obtained for simulation time of 100 seconds is

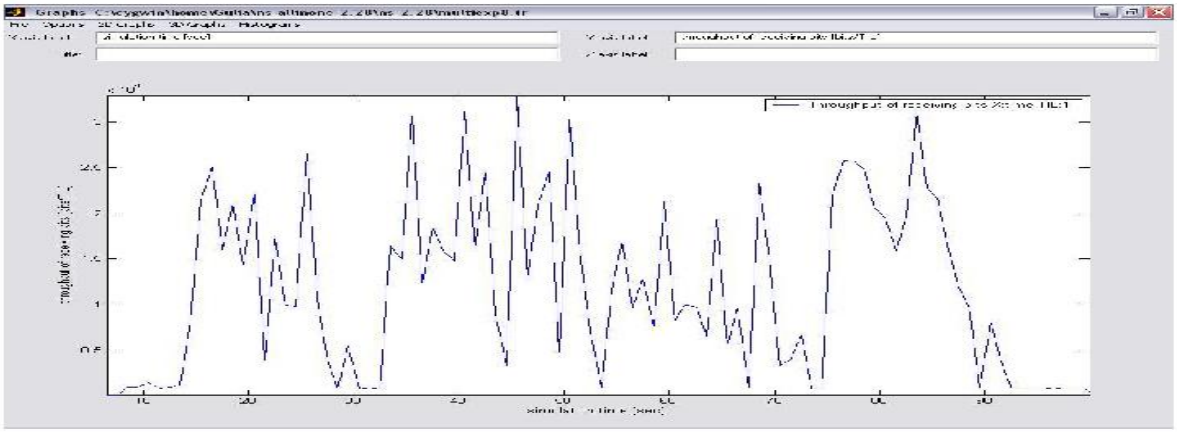

Figure 10 – Throughput of Receiving Bits versus Simulation Time

Throughput for 12 nodes, when used as a set of three 3-hop transmissions (node0 to node3, node4 to node7, node8 to node11) if all the three sets are transmitting simultaneously, is approximately 30kbps. This value is same as that of a single 3-hop transmission. This indicates that whether it can be any number of nodes, the transmission occurs between 4 nodes i.e. 3-hop without interrupting the transmission of other nodes at a time.

C. Comparison of Throughput for Different Number of Nodes:

We have calculated the throughput by taking a different number of nodes all in an active state. The comparison of throughput can be shown as

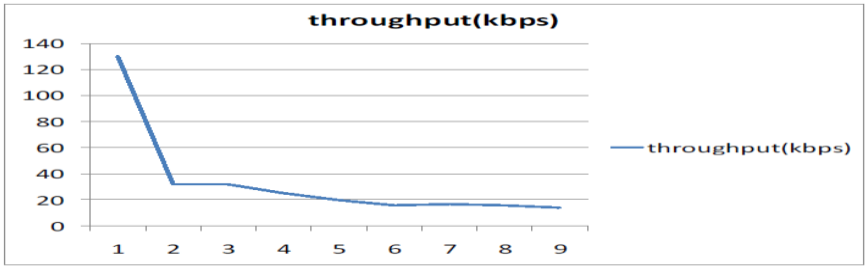

Figure 11 – Throughput of receiving bits versus Number of Hops

We can say that the throughput, in this case, is very less. Also, we can notice that by increasing the number of nodes the throughput decreases. This is because of the increase in the collisions and delay. This also leads to loss of information.

CONCLUSION

In the presented work, we have calculated the throughput for 10 nodes and analyzed the results by NS-2. Also, we have discussed a comparison of throughput of receiving bits using a different number of nodes. With the results of the trace graph, we can conclude that the throughput of single-hop transmission is 120kbps theoretically and 130 kbps by NS-2. The throughput for multi-hop transmission as a set of 3-hop transmission is 30kbps. This is same for any number of nodes. The throughput for 10 nodes, when used as a set of 3-hop, is also 30kbps. But when all the 10 nodes are the inactive state it is achieved as 14kbps. This is what we have to achieve. We can see that the throughput decreases when we increase the number of nodes. This is because when the active nodes increase in number they use to interact with each other. Due to this increased interaction, a node receives data from more than one node and hence results in data collision. This collision will further result in information loss and increase in delay.

FUTURE SCOPE

Here we have achieved the throughput of single-hop transmission as 130kbps and that of 10 nodes as 30kbps and 14kbps in the worst case. This is very less as compared to standard 250kbps. This result can be increased by using various techniques like using data transmission without sending acknowledgment frame. Also in the case of multi-hop transmission, we can use multi-channel approach. This will also increase the throughput.

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