# Performance measurement of QoS parameters of Throughput Enhanced Wireless in Local Loop Architecture

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**Abstract -** *In the existing Throughput Enhanced Wireless in Local Loop (TWiLL) system, the Packet Acceptance Ratio vs Mean Call Holding Time decreases from 1 to 0.4 with increase in time and the Packet Acceptance Ratio vs Mean Inter Call Arrival Time increases from 0.4 to 0.5 with increase in time. The number of subscribers in Wireless Networks such as Wireless in Local Loop (WiLL) is increasing, thereby it becomes beneficial to use spectrum reusability techniques. To improve the capability of WiLL systems, multi-hop relaying is used. In the existing WiLL system, number of subscribers that can be simultaneously served is limited, with increase in subscriber density. It is to develop Throughput Enhanced Wireless in Local Loop (TWiLL) architecture that uses multi-hop relaying and shortcut relaying to reuse bandwidth of the system. The technological challenges faced by the existing system are its performance output obtained by analyzing the Packet Acceptance Ratio vs Mean Call Holding Time and Packet Acceptance Ratio vs Mean Inter Call Arrival Time of existing TWiLL system is less as compared to that of the proposed TWiLL system. The current work done focuses on designing a TWiLL system with a Packet Acceptance Ratio vs Mean Call Holding Time of 0.9 (increase in 0.5) and Packet Acceptance Ratio vs Mean Inter Call Arrival Time of 0.9 (increase in 0.4).*

***Key Words***: **Multi-hop relaying, Packet Acceptance Ratio, Single hop relaying, Shortcut relaying, Wireless in Local Loop**

## 1. INTRODUCTION

A Wireless in Local Loop (WiLL) system comprises of a set of fixed subscribers connected to the PSTN through a radio link as shown in Fig.1.

The geographical region is separated into a number of cells and at center of each cell a Base Transceiver Station (BTS) is assigned. The BTS communicated with the fixed subscribers over the wireless link and PSTN over a wired link. The equipment which is used for communication with the BTS, at the subscriber premises is known as the Fixed Subscriber Unit (FSU).[1]

WiLL system offers many advantages like ease and low cost of deployment and maintenance. While the amount of subscribers in WiLL systems keep on increasing, the electromagnetic spectrum's capacity remains the same. Hence the number of subscribers that can be simultaneously served is limited.

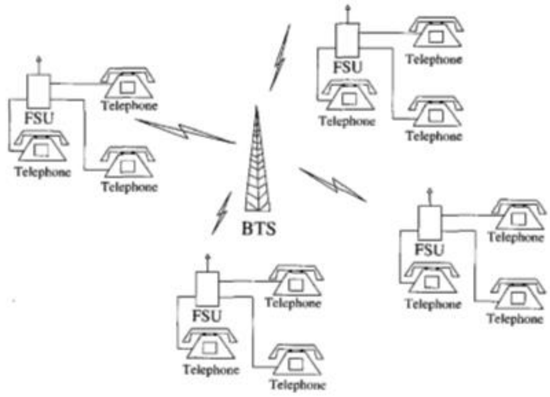


**Fig-1 :** Wireless in Local Loop System

To overcome this limited usability Throughput Enhanced Wireless in Local Loop (TWiLL) systems are used. TWiLL is an architecture which uses methods like multi-hop relaying and single hop relaying to reuse system bandwidth. [2]

The layout of the paper is as follows. Section 2 describes about literature review, Section 3 states about the Problem Definition, Section 4 describes about the TWiLL Architecture, Section 5 explains about the Packet Acceptance Ratio, Section 6 shows the Simulation Results and Section 7 states the Conclusion of the paper.

## 2. LITERATURE REVIEW

The performance measurement of QoS parameters of throughput enhanced wireless in local loop architecture is evolved from various standard technical papers as mentioned below. These papers along with certain research work over the internet has enlighten methods and techniques which are used towards the proposed approach presented in this paper.
In the papers,
[1] "Performance of the Throughput Enhanced Wireless in Local Loop Architecture Using Multi-dimensional Markov Chains", published in April 2005 by the authors, V Mythili, B. S. Manoj, and C. Siva Ram Murthy,
[2] "On Using Multidimensional Markov Chains for Performance Evaluation of Hybrid Wireless Networks",

published in December 2006 by the authors, B.S.Manoj, V. Mythili Ranganath, and C. Siva Ram Murthy, and
[3] "A Wireless in Local Loop Architecture Utilizing Directional Multihop Relaying", published in September 2004 by the authors, V. Mythili Ranganath, B. S. Manoj, and C. Siva Ram Murthy, the authors have explained about Wireless in local loop (WiLL) systems that faces the limitation that with the increase in amount of subscribers in WiLL systems, the electromagnetic spectrum's capacity remains same. As a result the number of subscribers that can be simultaneously served is limited. This limitation can be overcome by using Throughput Enhanced Wireless in Local Loop (TWiLL) systems which makes use of multi hop relaying and shortcut relaying to reuse system bandwidth.
[4] In the paper, "Multihop Cellular: A New Architecture for Wireless Communications", published in March 2000 by the authors, Ying-Dar Lin and Yu-Ching Hsu, authors state the limitations faced by networks with Single hop channels (SCN) about path vulnerability encountered in ad hoc networks and how it can be overcome by using multi hop channels (MCN) where multiple hops among bases are allowed which improve the throughput performance of the network.
[5] In the paper, "Integrated Cellular and Ad Hoc Relaying Systems: iCAR" published in October 2001, by the authors, Hongyi Wu, Chunming Qiao, Swades De, and Ozan Tonguz, the authors explain the limitations about the congestion problem due to unbalanced traffic faced by the conventional cellular networks and how it can be overcome by using the Integrated Cellular and Ad hoc Relaying Systems (iCAR) which improves the call blocking/dropping probability, throughput and signalling overhead of the system.
[6] In the paper, "Multi-hop Cellular Networks: The Architecture and Routing Protocols" published in October 2001, by the authors, Ananthapadmanabha R., B. S. Manoj and C. Siva Ram Murthy, the authors extend the research work carried out by Ying-Dar Lin and Yu-Ching Hsu, and explain how the performance of MCNs is better than the SCNs under various load conditions (both TCP and UDP).

The research gaps found after reviewing the above papers in the literature survey section are considered as issues to be implemented using problem definition.

## 3. PROBLEM DEFINITION

- To design a TWiLL Network with 50 nodes, spread over a terrain of dimensions 500 m x 500 m.
- To implement basic communication in Mobile Network using AODV protocol having multiple communications channel.
- To implement Cluster Formation and Cluster Head Selection, a master node is selected in each cluster and rest of the nodes are taken as slave.
- To calculate the Packet Acceptance Ratio vs Mean Call Holding Time by varying the Mean Call Holding Time between 1 – 30 sec among nodes
- To calculate the Packet Acceptance Ratio vs Mean Inter Call Arrival Time by varying the Mean Inter Call among nodes

## 4. TWILL ARCHITECTURE

TWiLL Architecture is shown in Fig. 2. In TWiLL, every radio channel is selected as a multi-hop channel (MC) or a single-hop channel (SC). A node is also known as a Fixed Subscriber Unit (FSU) is used to transmit radio signals in a WLL system.[3] Every node transmits a Single Hop Channel (SC) with a range of R which is cell radius, and multi hop channel (MC) with a range of r = R/2.

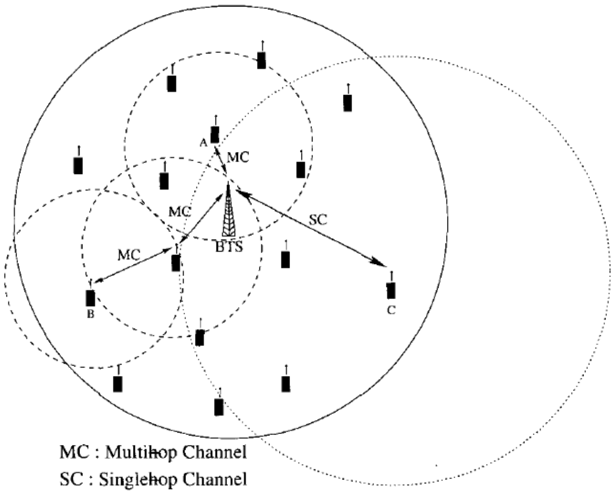


**Fig-2 :** The TWILL Architecture

Node A and node B are connected to the Base Transceiver Station (BTS) through multi-hop paths. Node A can reach the BTS over a one hop while Node B can reach the BTs with two hops. Node C cannot reach the BTS with multi-hops, hence it uses a single-hop channel (SC) to communicate with the BTS. [4]

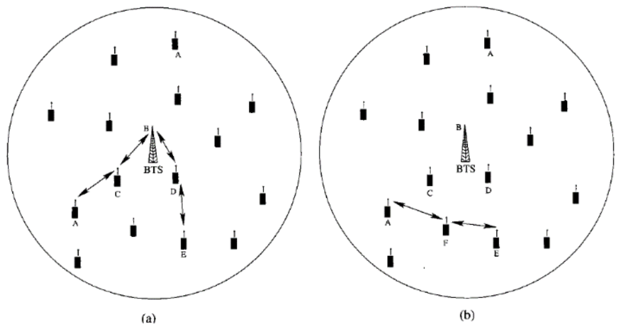


**Fig-3 :** Call setup in TwiLL for local calls (locality = 1) (a) Normal relaying (b) Shortcut relaying

The locality (L) of the system can be defined as the probability that a calls destination is within a same cell as the calls source.[3] In TWiLL, a technique called shortcut relaying uses the locality of the system to improve the throughput of the system. Fig. 3 (b) shows shortcut relaying while Fig. 3 (a) shows normal relaying. In shortcut relaying, Node A sets up a call to Node E which is present in the same cell as node A. Under a normal WiLL system it does not need to go to node C and BTS, and from there establish a connection to node D and node E. Thus shortcut relaying improves the efficiency of the system as the node E is directly connected to node A, and it avoids the path to go from node C to BTS and then node D to node E. This path setup is coordinated by the BTS, as node A does not have the knowledge of the network topology. [5]

The flowchart is as shown in Fig. 4.

1. To start a call over the control channel, a node sends a Route Request (RReq) packet to the BTS.
2. The BTS computes a multi-hop path (MC) from the node to itself.
3. If a path is obtained, it allocates MCs along the path.
4. If such a path cannot be found, then the node assigns single hop channel (SC) to communicate directly with the BTS

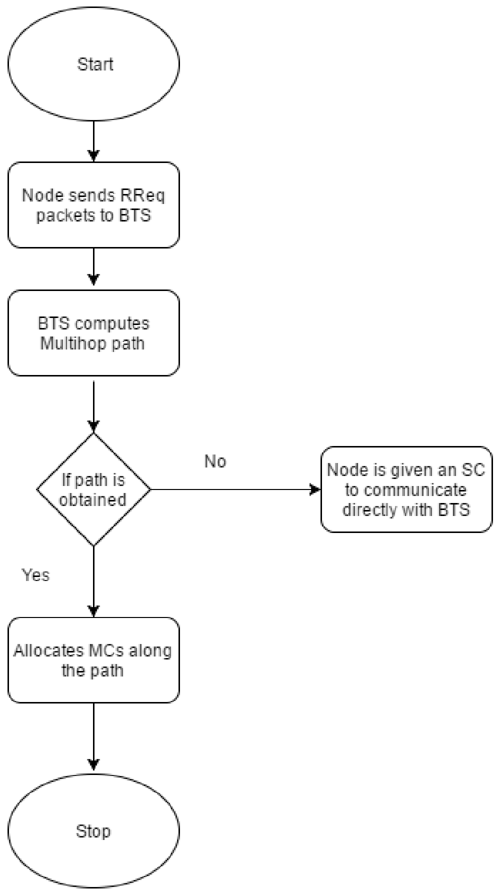


**Fig-4 :** Flowchart of Proposed TWiLL system with Normal Relaying

## 5. PACKET ACCEPTANCE RATIO

Packet Acceptance ratio can be defined as the ratio of the number of packets successfully delivered to the destination node upon the total number of packets sent by the sender node.

Packet Acceptance Ratio = No. of packets successfully delivered / Total no. of packets sent

## 6. SIMULATION RESULTS

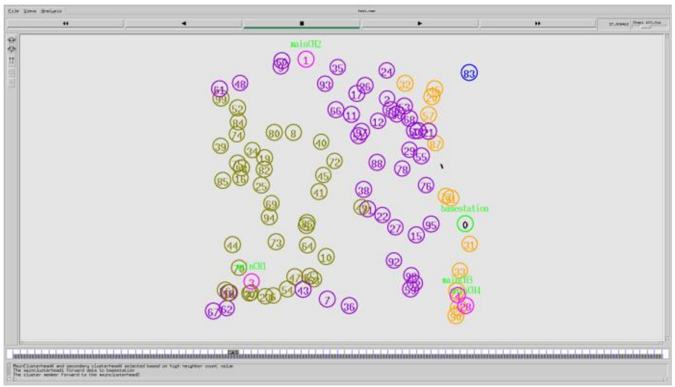

**Fig-5:** Simulation of network in Network Simulator 2

To evaluate the performance of the TWiLL system, a network with 50 -100 nodes is simulated in Network Simulator 2. The communication between the various nodes is analyzed and the Throughput, Packet Acceptance Ratio and Packet Drop of the network is measured in the system. The red segment in the graphs below denote the proposed system data values and the green segment denotes the existing system data values.

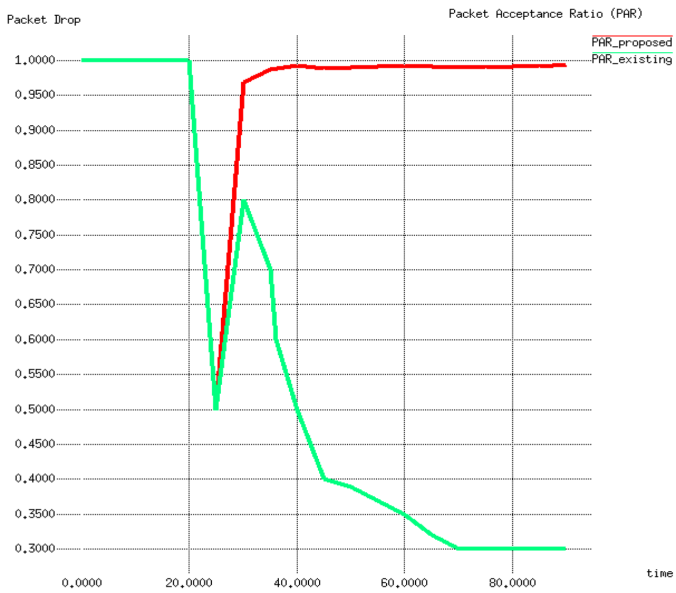


**Fig-6 :** Graph of Packet Accceptance Ratio vs Mean Call Holding Time

In Fig.6, the graph of Packet Acceptance Ratio vs Mean Call Holding Time of the network is shown. It can be seen from the graph that the packet acceptance ratio is low when the calling starts at 26 sec but then it increases and remains constant at around 0.99 for various values of mean call holding time of 10 sec , 20 sec and 30 sec. The Packet Acceptance ratio of the existing system is 0.8 the highest and 0.3 the lowest. The minimum packet acceptance ratio of the proposed system achieved is 0.5 and maximum achieved is 0.99.

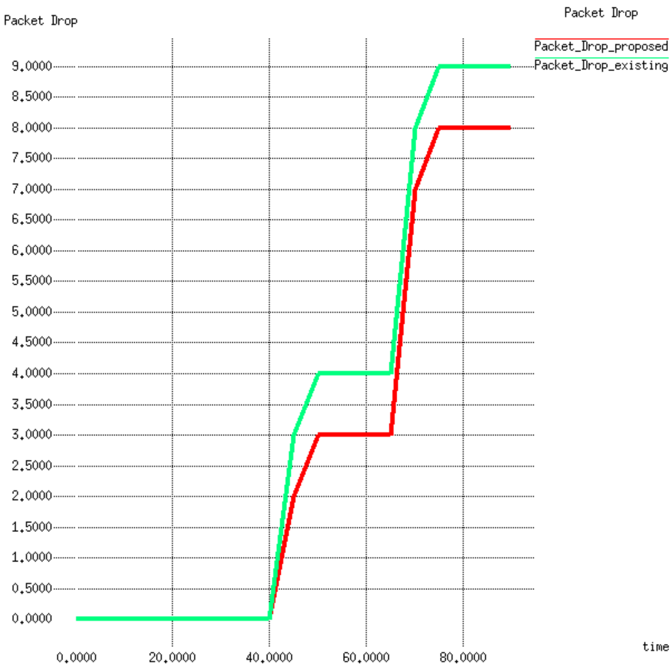


**Fig-7 :** Graph of Packet Drop vs Mean Call Holding Time

Fig. 7 shows a graph of Packet drop vs Mean Call Holding Time in the network. It can be seen from the graph that there is no packet drop in the initial stages but later the packet drop increases. The packet drop is 0 till 40 sec, it gradually increases to 3 bps till 65 sec and it increases to 8 bps till 90 sec. The Packet drop of existing system is highest at 9 bps.

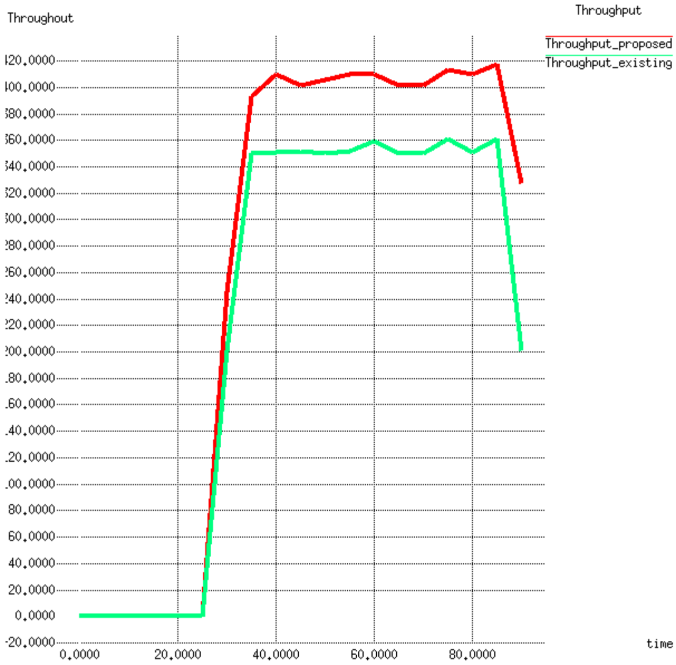


**Fig-8 :** Graph of Throughput vs Mean Call Holding Time

Fig. 8 shows a graph of Throughput vs Mean Call Holding Time in the network. It can be seen from the graph that there is no throughput till 26 sec. But when the calling starts after 26 sec the throughput increases to 400 bps and it varies to 410 bps till 85 sec and after the calling is complete it drops down. The throughput of existing system is highest at 360 bps.

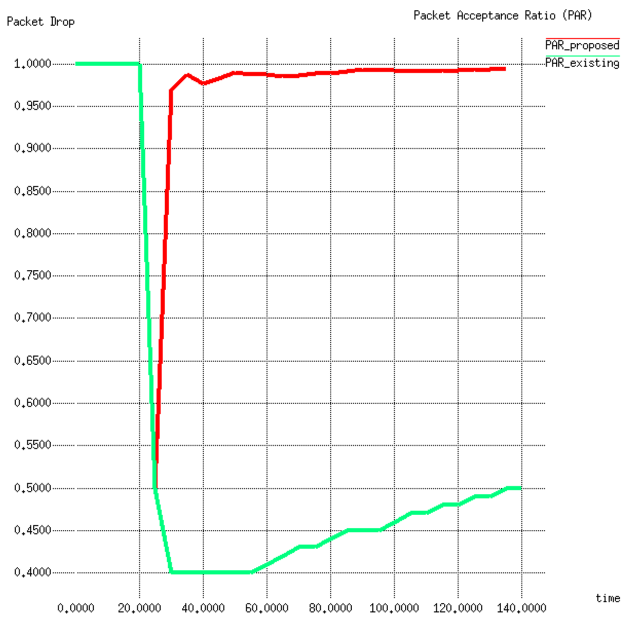


**Fig-9 :** Graph of Packet Acceptance Ratio vs Mean Inter Call Arrival Time

In Fig.9, the graph of Packet Acceptance Ratio vs Mean Inter Call Arrival Time of the network is shown. It can be seen from the graph that the packet acceptance ratio is low when the calling starts at 26 sec but then it increases and remains constant at around 1 for various values of mean call holding time of 10 sec , 20 sec and 30 sec. The Packet Acceptance Ratio of existing system is 0.4 and it raises to 0.5. The minimum packet acceptance ratio of the proposed system achieved is 0.5 and maximum achieved is 0.9.

Fig. 10 shows a graph of Packet drop vs Mean Inter Call Arrival Time in the network. It can be seen from the graph that there is no packet drop in the initial stages but later the packet drop increases. The packet drop is 0 till 35 sec, it gradually increases to 4 bps till 75 sec and it increases to 5 bps till 135 sec. The packet drop of existing system is highest at 6 bps.

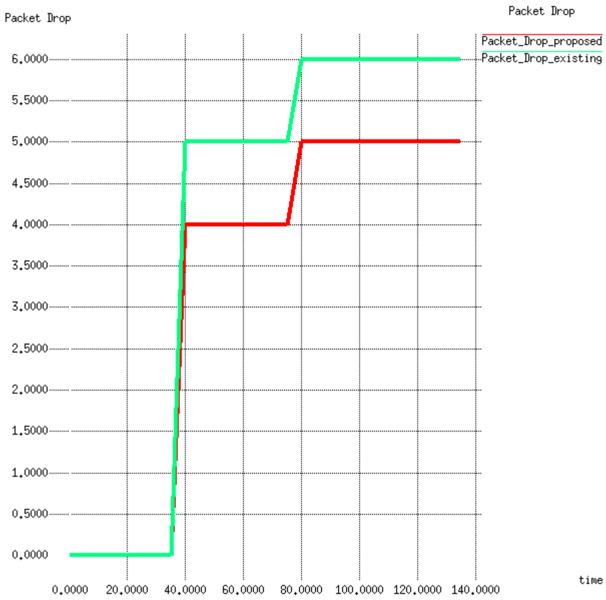


**Fig-10 :** Graph of Packet Drop vs Mean Inter Call Arrival Time

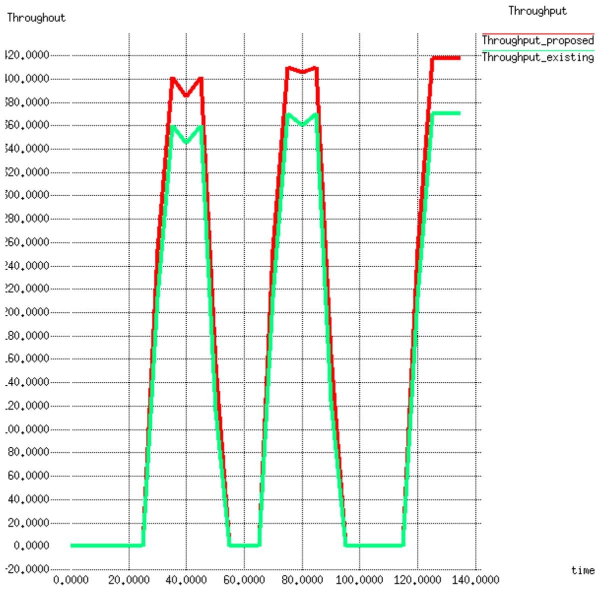


**Fig-11 :** Graph of Throughput vs Mean Inter Call Arrival Time

Fig. 11 shows a graph of Throughput vs Mean Inter Call Arrival Time in the network. It can be seen from the graph that there is no throughput till 26 sec. But when the calling starts after 26 sec the throughput increases to 400 bps till 55 sec and then again drop down to 0 as there is a call interval of 20 sec, it goes up to 400 bps again for a period of 20 sec and after the call is complete it drops down to 0 for an interval of 30 sec, it then goes up again for 400 bps when there is a call for 20 sec. The throughput of existing system is highest at 370 bps.

**Table-1**: Results Summary

| Parameter | Results Reported | | | Results Achieved | | | Difference between Results Achieved and Results Reported | | |
|---|---|---|---|---|---|---|---|---|---|
| | Packet Acceptance Ratio (PAR) | Packet Drop | Throughput | Packet Acceptance Ratio (PAR) | Packet Drop | Throughput | Packet Acceptance Ratio (PAR) | Packet Drop | Throughput |
| Mean Call Holding Time | 0.8 | 9 | 360 | 0.99 | 8 | 410 | 0.19 | -1 | 50 |
| Mean Inter Call Arrival Time | 0.5 | 6 | 370 | 0.99 | 5 | 400 | 0.49 | -1 | 30 |

## 7. CONCLUSIONS

Multi-hop relaying results in significant bandwidth reuse in WiLL architecture and therefore TWiLL system performs steadily better than the traditional WiLL systems. It is observed that the TWiLL architecture provides a maximum throughput of 410 bps, Packet Drop of 8 bps and Packet Acceptance Ratio of 0.99. We have validated our analysis with experimental values from simulations and thus verified the correctness of our model.

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