International Journal of Information and Communication Technology Research

http://www.esjournals.org

Network Model Diversity for Wireless Studies

Haniza N., Shahrin S., Zulkiflee M, Zakiah A.
Department of Computer System and Communication,
Faculty of Information and Communication Technology,
Universiti Teknikal Malaysia Melaka, Melaka, Malaysia

ABSTRACT

Wireless network is one of interesting research domain. Many studies have been conducted related to security and network performance issue. There are two methods to represent a conducting study either based on test bed or simulation in order to access the real network environment. With a suitable network model selection, any research might achieve its objective. Therefore, this paper provides a collection of network models that has been used particularly in wireless network to assist researchers on selecting an appropriate network model for their conducting study. The result gathered from various technical and theoretical research papers. In future, the intention on more generic justification of selective parameters to be used for wireless study will be shared later on.

Keywords: *Network topology, wireless, wired cum wireless, hops*

1. INTRODUCTION

Basically, wireless refers to non-physical connections between communicating nodes. It operates based on radio frequency (RF) coverage as long as it stills located within each other's transmission range which then determines the successfully of the exchanges data. Otherwise, the failure of data exchange will be occurred whenever node moves away or located out-of sender's transmission range. In the wireless architecture, it consists of two different modes: ad hoc and infrastructure mode. The main difference can be presented by the present of an equipment called as an Access Point (AP) which implements Point Coordinate Function (PCF).

As mentioned before, this paper purposely to list out several types of wireless network topologies that has been used. As stated by Floyd [1], a suitable network model must be chosen based on several criteria which are:

1. The chosen models based on research questions
2. The effect of chosen parameters on the experiment
3. The specific measurement
4. The realistic model designs.

Therefore, any researcher who are working on wireless domain should look this platform as a good starter on selecting wireless network topology to be referred.

2. NETWORK MODELS

Figure 1 shows the general network model for wireless. It has been categorized into two main groups namely basic and diverse model. The underlying of this model is depending on a number of nodes involved and nodes arrangement.

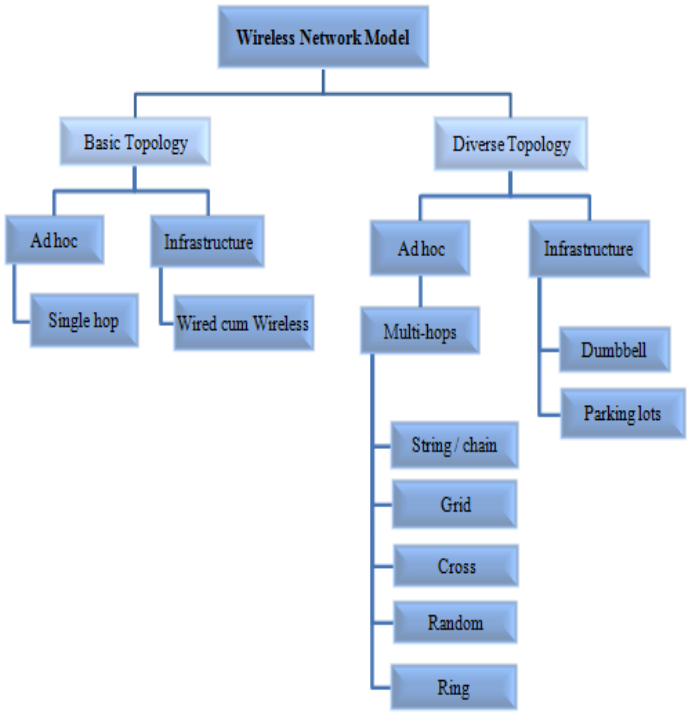

Figure 1: A network model for wireless

By varying nodes arrangement representing real network environment, many research questions can be explored and studied. Several factors possible affect the behavior of wireless network help researcher to understand and justify what actually happens.

For instance, there is a simple topology consists of two ad hoc nodes that use IEEE 802.11b specification. The default transmission range is given by 250 meters and its interference range is about 550 meters. Whenever additional nodes joins its coverage, the situation such as hidden or expose node problem need to be considered.

2.1 Basic Topology

As a base, it just involves at least two or three nodes. For an ad hoc network, a single hop is referred to connection between two nodes as in Figure 2 (a). This simple topology representing two wireless computers interact each other by transferring data between them for short period. Meanwhile, an infrastructure mode represent both wired and wireless node separated by Access Point (AP) or base station as in Figure 2 (b). In this case, a simple Wireless Local Area Network (WLANs) is an example of this basic topology.

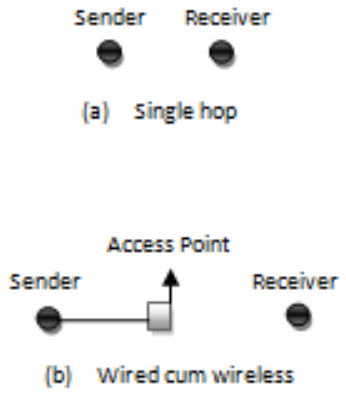

Figure 2: Simple topology presented in Single hop and Wired cum wireless

2.2 Diverse Topology

The main weakness of basic topology is it does not quite realistic and inadequate to represent real wireless network environment in larger scope. Therefore, the diversity of basic topology has been interpreted into more extended topologies. As mentioned before, the diversity is concerned about wireless nodes arrangement.

For the single hop, it has been extended into multi-hops where more than two wireless nodes involved. The nodes has been arranged into several forms such as string / chain, grid, cross, ring and random style. These network configurations has been illustrated as in Figure 3 (a)-(e). These topologies usually representing study in Wireless Sensor Network (WSN) and Mobile Ad hoc Network (MANET).

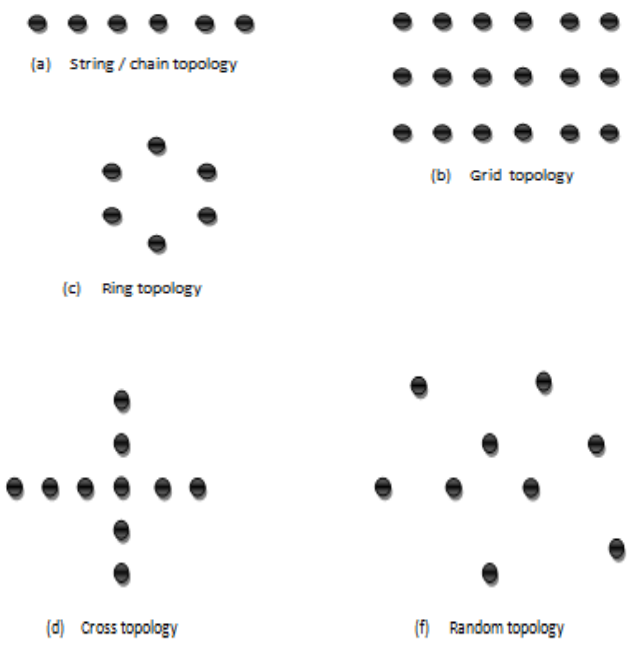

Figure 3: Multi-hops topologies

Meanwhile, the infrastructure or wired-cum-wireless category results into two generic forms such as dumbbell and parking lots. These topologies can be seen in Figure 4 (a) and (b) which plays an important role in managing wireless study particularly in Cellular Network, Mesh Network and Satellite Network.

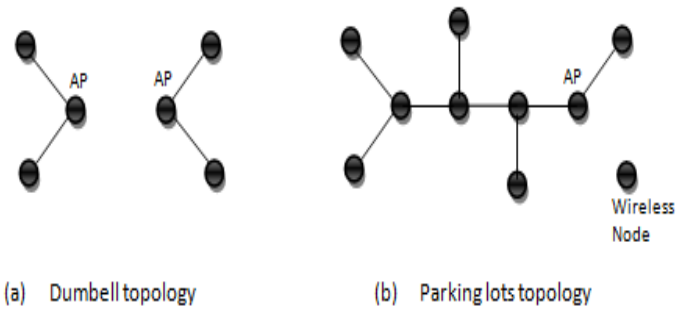

Figure 4: Infrastructure mode in extended topology

In this category, the wireless link can be located either at the last hop or as a backbone.

3. TYPES OF CONDUCTING RESEARCH

After listing out a variety of wireless topologies, the next important elements is what relevant investigations that normally run over these listed topologies and on how scenarios has been planned.

By referring Table 1, there are several conducting research on wireless studies has been collected. For both single-hop and wired-cum-wireless topology, they normally act as a baseline measurement. It is an important reference whenever the model's parameter setting being adjusted and how it affects the study during experimental stage. It includes observation on throughput, goodput, round trip time (RTT), latency, jitter, window size and others. In wireless, each node can be either static or dynamic. It means that wireless mobility also one of interested study to be investigated.

In the larger scope of wireless study, many observations have been done based on several factors such as number of users / hops, types of routing protocol, wireless error model, types of queue mechanisms, different levels of power management. After that, the observations findings lead to face other potential issues such as contention medium issue, hidden and expose nodes, misbehavior node and others.

In simple experiment, a single TCP flow is normally be used. The variety of study can be more complex when there are many traffics or flows being applied especially throughout bottleneck link. The mixture between different transport layer protocol (TCP and UDP) or a number of flows, divert the pattern of investigation likes stability, fairness, friendliness and also link utilization.

Table 1: Description on the usage of typical topology with relevant investigation

Topology	Investigation Pattern
Single-hop [9]	Basic measurements - Throughput, Goodput, RTT etc.
Wired cum wireless [10]	Basic measurements - Throughput, Goodput, RTT etc. Loss differentiation / notification Impact of wireless error Impact of mobility Impact of queue mechanism
Multi-hops [4][5][6]	Impact of number of hops Impact of routing protocol Impact of power levels Queue size
Dumbbell / Parking lots [7][8]	Stability Fairness Friendliness Link utilization

Meanwhile, Table 2 summarizes two common scenarios that normally used for experimental purpose. In the basic scenario which results into a baseline information, the standard parameter setting has been used as network configuration. For example, the data rate specification for IEEE 802.11b node is given as 1, 2, 5.5 and 11 Mbps or Maximum Transfer Unit (MTU) for TCP data is given as 1500 bytes. It is important to ensure that it represents real network environment.

For an advanced scenario, it can be seen that the pattern of investigation has involves external elements such as error model, background traffic and others. The direction of study is more on comparative evaluation to verify any enhancement that being proposed.

Table 2: The possible scenarios designed for experimental purpose

	How
Basic [9]	Run under standard environment - Under an acceptable transmission range and distance Vary in terms of standard parameter - data rate, size of window, size of packets, size of buffer's space
Advanced [6][7][8][10]	Apply error loss model - error free vs. with error - random vs. burst error Apply n-competing flows throughout a bottleneck link - with / without background traffics - TCP vs. UDP flows

3.1 Example

In this section, we choose to share an example of wireless study that use a variety of network topology [2]. The main objective to observe the effect of hops count that contributes to TCP Congestion Control performance degradation. The observation has been made in terms of throughput, end-to-end delay and packet loss ratio.

Investigate the effect of multi-hops for selected topologies

Parameters	Value
Routing Protocols	AODV
MAC Protocol	IEEE 802.11b
Channel rate	1 Mbps
RTS-CTS	On
Simulation Time	100 seconds
Simulation Topology	String, Ring and Grid
Number of Nodes	6 (string & ring) ; 12 (grid)
Packet Size	1000 bytes
Application Protocol	FTP
NS-2 version	2.34

Figure 5: The network configuration setting as an example

4. CONCLUSION

Until this stage, the objective of this paper has been organized accordingly. It can be seen that this paper contributes:

i. The diversity of wireless network model that representing real wireless network environment
ii. The understanding of investigation pattern that has been done using this models
iii. The common scenarios designed in a way to assist in wireless studies

Perhaps, it becomes a novel platform for researchers who interested to conduct study in wireless domain. By sharing the relevant usage of topologies with its possible investigations, it might helps to speed up the process of defining the study scope.

ACKNOWLEDGEMENTS

The research presented in this paper is supported by the Ministry of Higher Education Malaysian (MOHE) and Faculty of Information and Communication Technology (FTMK) at Universiti Teknikal Malaysia Melaka, Malaysia.

REFERENCES

[1] Sally Floyd & Eddie Kohler, (2002) "Internet Research Needs Better Models", ACM *SIGCOMM Computer Communications Review*, Vol. 33, No. 1, pp29-34.

[2] Haniza N., Md Khambari M.N., Shahrin S., Adid M.Monzer Habbal & Suhaidi Hassan, (2012) "Topology Influence on TCP Congestion Control Performance in Multi-hop Ad Hoc Wireless", International Journal of Computer and Communication Engineering, Vol. 6, No 10, pp63-68.

[3] Yuhua Liu, Yongfeng Zhao, Yongwei Meng & Kaihua Xu, (2009) "A TCP Congestion Control Approach over Wireless Networks", International Conference on Scalable Computing and Communications: The Eight International Conference on Embedded Computing, pp420-423.

[4] Kumar.S, Mahendra, Prakash. K, Senthil, (2010) "Wireless Congestion Control Protocol for Multi-hop Ad hoc Networks", International Journal of Computer and Information Security (IJCIS), Vol.1, No.1, pp. 25-31.

[5] Haniza N., Zulkiflee M., Abdul S.Shibghatullah & Shahrin S. (2011) "Congestive Loss in Wireless Ad hoc Network: Network Performance Analysis", World of Computer Science and Information Technology Journal (WSCIT), Vol.1, No.6, pp. 269-273.

[6] Pedro H. J. Nardelli, Paulo Cardieri & Matti latva-aho, (2012) "Efficiency of Wireless Networks under Different Hopping Strategies," IEEE Transactions on Wireless Communications, Vol.11, No.1, pp.15-20.

[7] R. Paul and Lj. Trajkovic, (2006) "Selective-TCP for Wired/Wireless Networks," Proceedings. SPECTS, pp. 339–346.

[8] Faisal Nawab, Kamran Jamshaid, Basem Shihada & Pin-Han Ho, (2011) "TMAC: Timestamp-ordered MAC for CSMA/CA Wireless Mesh Networks," Proceedings of 20th International Conference on Computer Communications and Networks (ICCCN), Vol., No., pp.1-6.

[9] Tuan Tran, Thinh Nguyen, Bella Bose & Vinodh Gopal, (2009) "A Hybrid Network Coding Technique for Single-Hop Wireless Networks," IEEE Journal on Selected Areas in Communications, Vol.27, No.5, pp.685-698.

[10] Ijaz Haider Naqvi & Tanguy Perennou, (2007) "A DCCP Congestion Control Mechanism for Wired-cum-Wireless Environments," IEEE Communication Society on Wireless Communications and Networking Conference (WCNC), Vol. , No., pp.3912-3917.

AUTHORS

Haniza Nahar, a Senior Lecturer at University of Technical Malaysia Melaka (UTeM). She earned MSc. in ICT for Engineers (Distinction) from Coventry University, UK and BEng. in Telecommunication from University Malaya. She used to be an Engineer and has been qualified for CFOT and IPv6 Software Engineer. Her postgraduate dissertation has been awarded as the *Best Project Prize*.

Prof. Dr. Shahrin bin Sahib @ Sahibuddin is a Dean of Faculty of Information and Communication Technology, UTeM. He earned PhD in Parallel Processing from Sheffield, UK; MSc Eng System Software and B Sc Eng Computer Systems from Purdue University. His areas of research include Network, System, Security, Network Admin and Design.

Zulkiflee Muslim, a Senior Lecturer at University of Technical Malaysia Melaka (UTeM). He earned MSc. in Data Communication and Software from University of Birmingham City, UK and BSc. in Computer Science from University of Technology Malaysia. He has professional certifications: CCNA, CCAI, CFOT and IPv6 Network Engineer Certified.

Zakiah binti Ayop received Bachelor of Computer Science from University of Technology, Malaysia, 2000. She joined University of Technical Malaysia, Malacca (UTeM) as a Tutor in Faculty of Information Technology (2001). She completed her MSc. in Distributed Computing (2003) from University of Putra, Malaysia. She returned back to UTeM as a lecturer. Her research interests are trust and reputation system, information and network security; and crowd sourcing.