

A Comparison between two different network technologies -Power Line communication (PLC) and Wireless Network Technology(WNT)

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ABSTRACT: Wide range of network technologies are used to interconnect devices within the home multiple application, varying from simple internet access to complex home automation. This paper represents an overview of installing, evaluating and testing two different network technologies with different adapters in a small environment, which consist of three story house and basement. A Devalo dLAN power line adapter used in the basement and second floor for the power line communication, Whereas the D-Link Cover-1203 used in the ground and first floor for the wireless mesh network (WMN). In addition, it focuses on Measuring the speed of the PLAs in different floors and in different distances away from the router and measure the speed of each nodes.

Date of Submission: 26-09-2022

Date of Acceptance: 13-10-2022

I. INTRODUCTION

Power-line communication (PLC) and mesh network are two different methods used to connect devices one to another or connects them to the internet. Power-line communication (PLC) uses the existing electrical wires in a building, the wires carry both AC electric power transmission and data simultaneously. It helps to expand an existing network into other new places without new wiring simply by utilizing every power socket as internet port using PLC adapter in addition to the ability of transforms electrical socket to Wi-Fi hot spot.

In other words, HomePlug standards and technology use the existing electrical wire in a building as network cables to communicate data between PLC's adapters by extending the existing network in order to provide wired and wireless connectivity from every electrical outlet. For example, a computer and a printer are placed from each other and in an area not covered by existing Local Area Network (LAN). Thus, the ability to connect to the internet is possible by using electrical wires and three PLC adapters, these PLC adapter are placed as follows: Connecting one adapter to a router of an available wired Local Area Network (LAN) via its network port, the second adapter is to connect the computer, and the third one is to connect an Ethernet-ready devices like a printer. When the three adapters are plugged into the wall sockets they will have a network connection via the electrical wiring in between the computer and printer on one side and the router on the other side (connecting devices to the internet) and in between the computer and printer (connecting devices to one another). Some networking devices, such as switches or routers have built in power line connectivity, which will enable them to access the internet ones plugged into the power socket. However, the Wireless Mesh Network (WMN) technology uses different concept, it evolves into the next generation to provide a better single services for the development. In WMNs, nodes consist of routers and mesh clients. Each node operates as a host or a router, forwarding packets on behalf of other nodes that may not be within direct wireless transmission range of their destinations. A WMN is dynamically self-organized and self-configured with the nodes in the network automatically establishing and maintaining mesh connectivity among themselves. That is, all points are connected to each other wirelessly. As long as they are within range, they can communicate with one another wirelessly without the need for a router or switch.

II. METHODOLOGY

Power-line setup connection can be extended as large as the building they are used in; its solution starts with minimum of two adapters. Plugging in the first adapter into a power outlet then connects it to the router. Whereas the second adapter is plugged in another power outlet enabled the two adapters to communicate using the existing power line as a data lines. The first adapter takes the Ethernet protocol used by your router and

converts it into a Powerline protocol that uses electrical signals to send data through the wiring in the house to the second device. The second adapter receives the Powerline protocol and returns it back into an Ethernet signal.

The Technology of the Power Line Adapter (PLA) uses standards called HomePlug to allow communication between any two adapters to ensure the transmission of data over electrical wires with no corruption and noise. Which mean that Power-line networking can provide both wired and Wi-Fi connection to any device with Ethernet port or Wi-Fi enabled can connect to the internet.

On the other hand, the mesh network is based on the distribution of nodes in a place to transfer information to and from the Internet. The nodes are programmed through preset firmware that tells the nodes how to handle information and interact with the network, in our constructed WMN we have set master node connected physically to the router and up to four nodes distributed thru the house with a setup allowing their signal to intercepts to let these nodes routing data thru the network and to the router.

Mesh networks technology send messages by using the routing or flooding methods. In routing, a message trips from node to node to reach to its destination. The mesh network must have continuous connections and reconfigure itself if a path is broken, using self-healing algorithms. There will always be more than one route between a source and a destination which will support the reliability of the network .Flooding methods rely on distributing data from one node to the rest in a network. Data is sent by a subset of the nodes because all nodes may not be available at one time. Each node has a subset of the data. A protocol chooses the senders for every data transmission to maximize throughput.

III. EVALUATION

The two different networks have been tested in three story house with a basement were the main wireless router located in the first floor. Whereas the distribution switch is located in the ground floor connected to the main router via ethernet (CAT6) The basement and the second floor had a PLA plugged and connected to the router through the switch via Ethernet cable. Now, every power socket in the basement and the second floor can act as Ethernet port or Wi-Fi adapter using the proper PLA. In contrast, the WMN in the ground and first floor is dynamically self -organized and self – configured with the nodes in the network automatically establishing and maintaining mesh connectivity among themselves as shown in Figure (1).

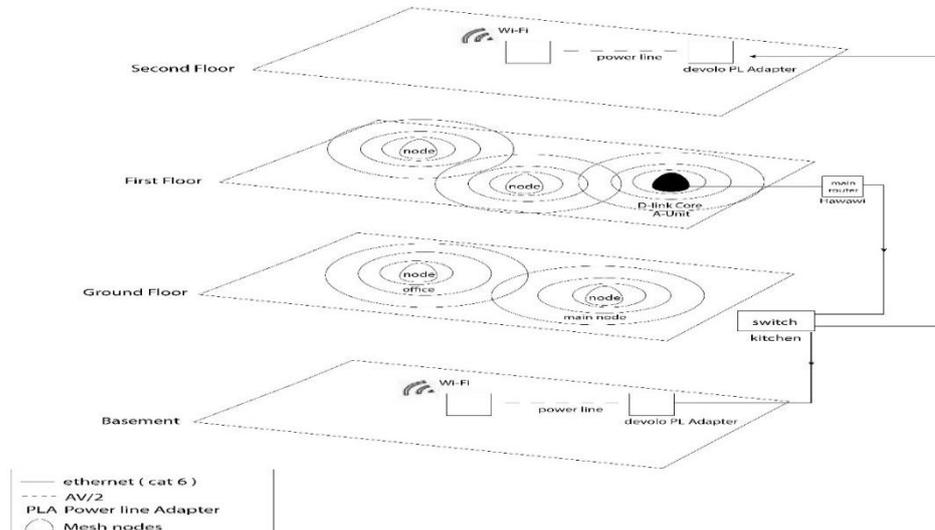
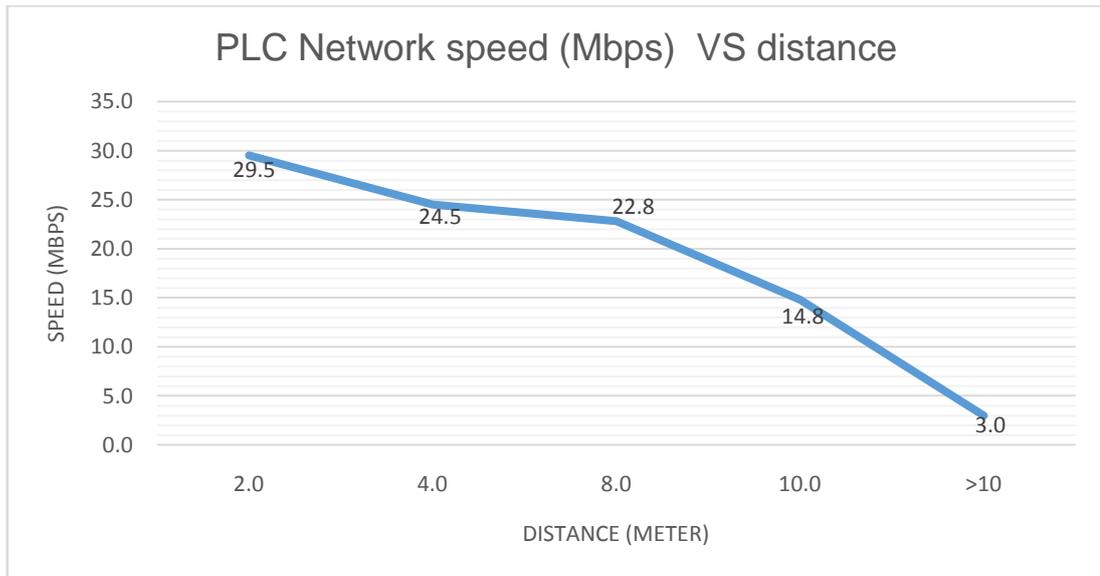


Figure (1): Network Layout

In a study to evaluate the speed of data transmission in the PLC network against location of Wi-Fi adapter (distance) result was collected and tabulated in Table (1) and the graph shown in Figure (2).

	adapter (masa 12)				
distance (meter)	2.0	4.0	8.0	10.0	>10
speed (Mbps)	29.5	24.5	22.8	14.8	3.0

Table (1):PLC download speed recorded data

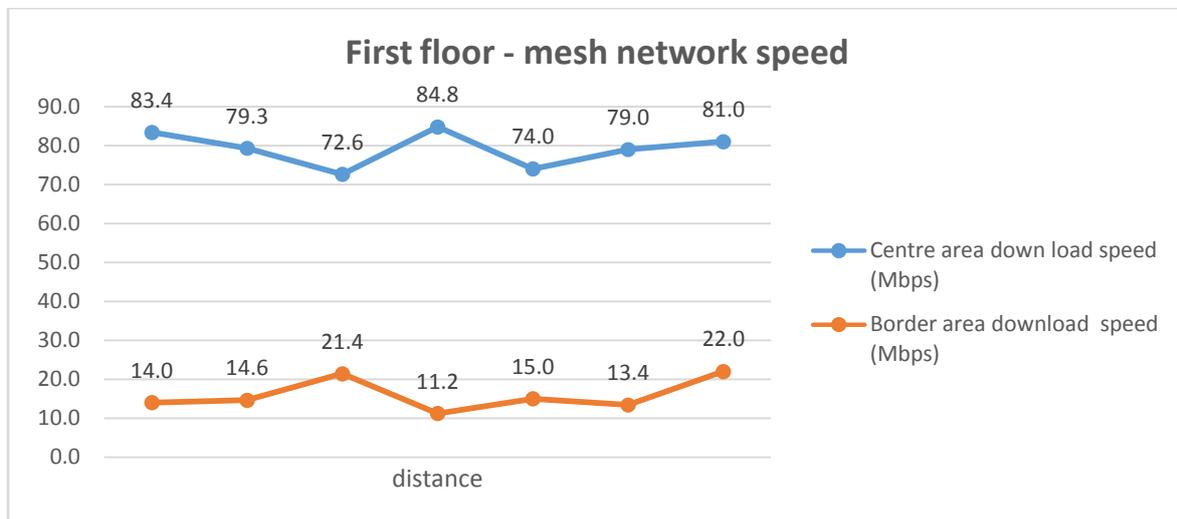


Figure(2):PLC Network speed (Mbps) VS distance

Though, the result of testing the download speed in the WMN is presented in table (2) where the device is placed in different spots of the mesh network, in the center and at the border of the network coverage, the result graph is shown in Fig (3)

	First floor -Mesh network						
Centre area down load speed (Mbps)	83.4	79.3	72.6	84.8	74.0	79.0	81.0
Border area download speed (Mbps)	14.0	14.6	21.4	11.2	15.0	13.4	22.0

Table (2): Mesh network download speed recorded data



Figure(3):mesh network speed

IV. FINDINGS

- Download speed is affected with the distance in PLC network.
- The three different electrical phases (yellow, blue, red) has no effect on the adapter communication (no interference) in PLC .
- In WMN the speed of data transmission is nearly stable, either at the center or the border of the WMN .
- The WMN gives a faster speed ,which means that the drop in the download speed of the router while connecting via mesh network is less than the PLC network .

V. Security and privacy

Electrical signals can be hacked, just like eavesdropping on a Wi-Fi signal is possible. Therefore, it is important to pick a Powerline adapter with the best encryption technology available (WPA, wpa2). Adapters usually come with security buttons that, when activated, encrypt communications. That is true for the WMN as well, it has an end to end encryption scheme to maintain the client information privacy, where data is secured from sniffing while travelling between wireless nodes.

VI. PLC Advantages and disadvantages:

i. Advantages:

- Installation of Additional cables and network hardware is not required to set up a home networking: The PLC uses the existing electrical network for communication.
- Easy setup: Powerline networking is easy to install; a person can do it in just a few minutes. If there's only one or two devices in your home that need the Internet, Powerline may be the most consumer-friendly solution for you
- The availability of communication service can be on every outlet: The PLC uses the existing power outlets and power lines in the house to send and receive information's from one device to another.
- Saving money on installations: The cost of installation is lower than other communication system, suppose you have a device that can connect to the Internet with a wired Ethernet connection, but it doesn't have Wi-Fi. Unfortunately, your router is on the other side of the house therefore you need to connect wires which are inconvenient in our case. Purchasing a pair of Powerline adapters is a faster and more affordable solution.
- Solving Wi-Fi difficulties: There are some places that Wi-Fi can't be reached. Heavy interference or extra-large houses may make it too difficult to use a wireless connection. In these cases, Powerline adapters can supplement Wi-Fi networks or help provide one-on-one solutions for devices that really need a wired connection. This may also help with other problems, like spotty streaming or slow speeds that you would like to improve.

ii. Disadvantages:

- A common technical problem between wireless and power-line communication, particularly those of wide-bandwidth radio signals operating in a streamed environment. Radio interference, for instance, is a concern of radio groups.
- The efficiency and quality of the PLA connection are depending on the local electrical system quality. That is, improper wire installation and connection (e.g., circuit breakers) between the cables causes bad performance which leads to connection disturbance.
- Power line adapters needs to update the firmware.

VII. Mesh Topology Advantages and disadvantages:

i. Advantages:

- Scalability: it is simple where each node can act as a router you don't need to add additional routers to the network, however it is easy to setup because it has one access point and one password, as well as it is easy to add new devices.
- Robustness: do not rely on any fixed infrastructure, host rely on each other to keep the network connected. That is, if one of the nodes goes down, it doesn't necessarily bring the whole network down. The network can repair itself around a bad node if other nodes can complete the mesh.
- Cost: easy and low-cost networking for small home applications.
- Speed: gain speed with the additional bandwidth, because if one route become slow, the WMN could theoretically find a better route and adjust itself. Almost impossible to take down.
- Flexibility: the mesh topology has enormous flexible due to its partial shortage options. therefore, one node is not forced to have a complete set of connections for each node, the network can be built with a partial web.

ii. Disadvantages:

- Limitation: it takes up to five nodes.
- Security: vulnerability to security attacks.
- Speed: The speed is dependent on the location of the user (center or boarder) of the network

REFERENCES

- [1]. <http://ijireeice.com/upload/2014/january/IJIREEICE4A_a_vivek_powerline_communication.pdf>.
- [2]. Lacoma, Tyler. "Is Wi-Fi Too Unreliable? Powerline Networking May Be What You Need." Digital Trends. N.p., 08 May 2016. Web. 28 Mar. 2017. <<http://www.digitaltrends.com/computing/everything-you-need-to-know-about-powerline-networking/>>.
- [3]. Murty, Rohan, Jitendra Padhye, Ranveer Chandra, Atanu Roy Chowdhury, and Matt Welsh. "Characterizing the End-to-End Performance of Indoor Powerline Networks." (n.d.): n. pag. School of Engineering and Applied Sciences, Harvard University. Web. 28 Mar. 2017. <<http://www.eecs.harvard.edu/~rohan/papers/powerline-tr.pdf>>.
- [4]. V. Q. Son and N. T. A. Khoa, "Evaluation of Full-Mesh Networks for Smart Home Applications," 2019 International Symposium on Electrical and Electronics Engineering (ISEE), 2019, pp. 73-78, doi: 10.1109/ISEE2.2019.8920920.
- [5]. Wireless Mesh Networks: Security, Architectures and Protocols edited by Mutamed Khatib, Samer Alsadi
- [6]. Mesh Topology Advantages and Disadvantages | What is Mesh Toology? Advantages and Disadvantages of Mesh Topology - A Plus Topper.
- [7]. <https://arxiv.org/ftp/arxiv/papers/1504/1504.08213.pdf>