A study on the use of Wireless Mesh Network for Under-Connected areas using Onion Omega 2+

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Abstract

The gap between the population online and the population offline has caused a significant disadvantage to the offline population as a result of the digitalization of products and services in our current world. However, the investment required to digitalize the offline population is fraught with difficulties, as the potential profit and return of investment for the companies providing the service is difficult to ascertain. As such, the paper proposes a solution to the issue of necessary internet infrastructure by replacing it with IoT devices, specifically Onion Omega 2+, acting as nodes, connected via a Wireless Mesh Network. The ease of the scalability of the network makes it appealing for this purpose, however it is balanced by optimization issues concerning multi-hopping and its effects on latency and speeds.

Keywords: Internet Infrastructure, Multi-hopping, Offline Population, Onion Omega 2+, Scalability, Wireless Mesh Network

Ⅰ. Introduction

With the rise of the use of the Internet in daily activities, it can be argued that the development of tools and services on the internet has far-reaching consequences. More particularly, in areas where internet access is limited, people living in such areas are at a much bigger disadvantage as compared to their peers living in more urban and developed areas. According to the United Nations Department of Economic and Social Affairs (UN DESA), despite an increase in the use of the internet, with over 68% of the population online, it is estimated that over one-third of the population is still offline, with low-income countries having only 27% of their population on the internet [1].

One of the issues with this is the lack of available infrastructure that can support internet access. The investment required for such infrastructure is quite high, with admittedly low expectation of a return on investment. Companies would not want to service areas where they are uncertain of any potential profits, so would prefer to develop urban areas, where they can guarantee a larger target market. As such, there lies a gap in availability of internet access, with residents in rural areas disproportionally getting less internet coverage.

The solution proposed in this paper is the use of Onion Omega 2+ as a potential solution for internet access, with the use of Wireless Mesh Networking as the main network solution.

Ⅱ. Method

The system proposed in this paper is the use of an Onion Omega 2+ running a Wireless Mesh Network. The Omega 2+ is acting as the nodes in this system, with each node operating as both a router and a host, with each node forwarding packets to other nodes, even ones that are not directly connected within their range [2]. Wireless mesh networks can be categorized into three types:

1. Infrastructure mesh architecture, where routers create the links between the nodes, with the routers acting as a wireless backbone
2. Mesh architecture based on clients, where the client nodes are connected with a peer-to-peer link between the client devices, with no need for a mesh router, with the clients carrying out the function of the router
3. Hybrid mesh architecture, where it is a combination of client-based and infrastructure mesh [3].

The lack of any necessary internet infrastructure means that it is a suitable replacement for internet access in rural, underdeveloped areas.

The Onion Omega 2+ is chosen for this purpose as its built-in Wi-Fi antenna makes it particular suitable for this task. Its ability to act as both a router and a host means that it is suitable for functioning as the nodes in a Wireless Mesh Network. Its small size, along with its low power requirement means it is easy to implement in a variety of situations.

The general design of the network would be based on an Infrastructure mesh architecture type design, with each router acting as the wireless backbone of the system. The coverage of the network can be adjusted based on the total amount of nodes, with additional coverage requiring extra nodes to achieve.

With the Onion Omega 2+ specifically, it requires a modification to the factory condition of the device. More specifically, an OS like OpenWrt is more

appropriate given the use case. Omega 2+ does not initially support encrypted mesh networks, so additional packages must be installed to give the Omega 2+ better support for mesh networks. Additional packages can be installed in order to give ethernet functionality to the Omega 2+ .

The testing for the Wireless Mesh Network mainly involves testing the coverage of the network. The coverage test involves two tests.

1. Distance between Omega 2+
2. Distance between Personal Device and Omega 2+

The greater the distance that can be achieved while still being connected, the better the performance of the network.

The results of the testing of the distance between Omega 2+ are shown on the table below:

Table I

Connectivity testing between Omega 2+ nodes

Distance (m)	Connectivity
0	Connected
10	Connected
20	Disconnected

The results for the testing of the distance between Personal Device and Omega 2+ are shown on the table below:

Table II

Connectivity testing between Personal Device and Omega 2+

Distance (m)	Connectivity
0	Connected
10	Connected
20	Connected
30	Connected
40	Connected
50	Disconnected

Ⅲ. Conclusion

Given the results shown on the tables, it can be concluded that a mesh network coverage on Omega 2+ is primarily limited by the connection between each Omega 2+ device, as the range reaches around 10m for that particular test. However, when considering the range of the connectivity between Personal Device and Omega 2+, the range substantially increases.

With the results, the total coverage distance that was achieved with the Wireless Mesh Network running on Onion Omega 2+ was around 50m.

The potential for giving internet access to under-connected areas given the lack of appropriate internet infrastructure using Omega 2+ is an alluring possibility. The benefit for the offline population getting internet access is very obvious, with them being able to stand on equal footing with their urban counterparts. The relatively easy setup for the mesh network, and the easy scaling means it is an attractive alternative to permanent internet infrastructure.

The use of Wireless Mesh Network as the main backbone of a wireless solution can be very effective given the constraints, but it must be acknowledged that the investment for it, while being lower than a full infrastructure implementation, is still relatively quite high given the cost of each node. In addition to this, the use of Wi-Fi to connect each node may cause certain issues with speed and connectivity, as the distance between each node cannot be too far, and the use of multi-hop, while effective for increasing coverage, also increases latency and decreases internet speeds.
To conclude, additional research must be done to find appropriate ways to optimize Wireless Mesh Networks to make them more effective at covering large areas, preferably without sacrificing latency and speed. A more optimized multi-hop setup might give the mesh network the viability to function as an alternative networking solution.

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