Simple Smart Algorithm for Flexibility of Dynamic Allocation in DHCP Server for SOHO Wireless Router

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***Abstract*— An inherit problem exists in the small office home office (SOHO) wireless router is the connectivity issue, specially when dynamic host configuration protocol (DHCP)'s pool is running out. SOHO wireless router is designed to serve a small number of wireless clients. The modification of the OS is possible with some restrictions, especially the size. This research has modified the wireless router OS using simple smart algorithm to enhance the flexibility of dynamic allocation in DHCP server for SOHO wireless router. It switches the selection process of DHCP server that considering resource allocation of each joined DHCP relays. The modified wirelesss router is able to serve more than 10 times connected clients compared to using the original firmware with more than twice longer service time duration. This paper deals with the examination of the proposed simple smart algorithm in real SOHO wireless router.**

Keywords—SOHO; wireless router; DHCP; relay; server; Cisco; network; simple algorithm;

I. INTRODUCTION

Nowaday, wireless router becomes an essential device due the need for internet connectivity. It is used widely in small office, home, or dormitory because of its simplicity. User do not need any cable to connect to the internet which makes a tidy environment. The wireless router could support a network with several clients that require an Internet connection. Each client is provided both private and public internet protocol (IP) address. The IP distribution process could be helped by the DHCP server. It distributes the IP address to several network segments that joined in the network. However, the DHCP service can be unavailable because of the limit of the memory happened and a DHCP starvation attack [1]. In other side, the DHCP pool must always be available when clients in the specific part of the network request the connectivities.

In the network type C, a wireless router is able to provide IP address version 4 (IPv4) up to 253 clients [2]. However, for small coverage purpose as SOHO (small office home office) the number of connected client is limited to 15. Other problem is the connection may become unstable when it serves full clients for longer than 24 hours. Clients or other activities could overload the wireless router with low memory and low CPU so it is needed to be resetted. Switching of DHCP service served by the wireless router to DHCP relay could become an alternative solution for this problem because the DHCP relay takes the handling of the load.

Other solution is reprogramming the DHCP server. It can mitigate problems due to the lack of DHCP information because of the low resource. It is found that the resource of DHCP cand be overwhelmed by the running service or by the attack. This solution also can handle the proprietary limitation of branded wireless router. Some of them which act as the DHCP server for DHCP relay only can be connected to the same brand. In this situation, the OpenWRT can be used to bridge this problem. After some modifications, the wireless router can be connected to some generic brand routers. [3].

Several researches have been done in DHCP field. Relay agent was used to add information and compris a DHCP option in a generic router [4]. A combination of adaptive IP lease time and dynamic IP pool range was used to reduce IP peak usage based on usage pattern and user roles [5]. To limit DHCP broadcasting, MAC address of the client was stored somewhere in the network [6]. Factory firmware was modified by [8] to allow backward compatibility and co-existence of IP based application for different routers.

Other use of smart agen was proposed in [7], after detecting unsufficient memory allocation, it switched to the nearest DHCP relay as a backup, automatically. [8] proposed the DHCP agent that could operate in multi-IP connection and pool scenario. It was located between two routers to monitor different network segments. Smart agent also could detect the presence of users requesting a route planning in a certain path. The path planning was used to reroute the DHCP load to another router when low service reservation happened [9].

As a continuation of the previous research [1], the main contribution of this research is developing a smart agent to control the DHCP packet and auto triggering router command. It is an alternative solution for connecting multi proprietary limited device. This solution overcomes the limitation of a connected client and enhances the durability of the service. The smart gen is developed by using Phyton and installed on the PC. This paper presents performance examination of the proposed simple smart algorithm in real SOHO wireless router under Cisco old series.

II. THE METHODOLOGY

In this section, the research methodology is briefy exposed in two aspects, i.e. the simple smart algorithm and the parts of the proposed system.

A. Simple smart agent algorithm for master backup selection

A wireless router manages many services. It is hard to conclude the cause of stuck. Whether it is overloaded by the packages or worse by the hacking activities in a non-sense manner. This research modifies the mechanism of the firmware master backup selection algorithm to mitigate this problems.

Modification of the algorithm is simply checking the memory resource allocation and forward the load to the available resources . This is kind of load balancing method [15]. Memory resource allocation can be inspected by triggering resource check command to the router. The modification is done without changing the original behavior of the protocol. Analogicaly, it is like a man as a middle agent that triggered the command by inspecting the package.

The proposed smart agen algorithm is developed by Python script which has a flexible networking library. Figure 1 shows the flowchart of the proposed simple smart algorithm to modify the DHCP master-backup selection.

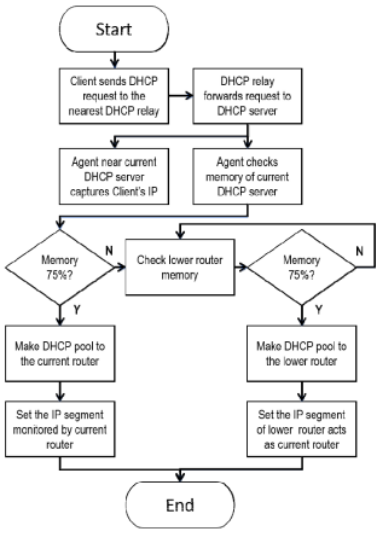

Fig. 1. The proposed simple smart algorithm to modify the DHCP master-backup selection.

Client always sends DHCP request to the nearest DHCP relay. DHCP relay forwards the package to the DHCP server. Everytime DHCP request is sent, the smart agent which observes all network segment connected to the network, inspects the DHCP request.

The proposed algorithm works after packet inspection. When the occupancy of the memory in the current DHCP server is still 75% then the DHCP pool is made in the current DHCP server. However, when the occupancy of the memory is more then 75% then the DHCP pool is made in the lower hierarchy router. The DHCP pool that exists in the previous router is not deleted except there is some adjustment. After the current DHCP IP is determined then the IP sent to the agent to change the monitored network segment.

B. Generic Router as DHCP server

First part of the proposed system is the DHCP server. Cisco old series generic router is taken as the examination environment. Each router makes some DHCP pool for each network segment that exists in the client network. Internet connectivity is shared via NAT mechanism. The router admin must ensure that the destination to default route, which is "0.0.0.0/0" in IPv4 is bypassed to router gateway which is connected with an available IP address.

Routing is needed to allow the smart agent which joins in one network segment can monitor another network segment. Simple dynamic routing used in this research is RIP version 2 protocol.

C. Generic Router as DHCP relay

A generic router can also be configured as DHCP relay. To do it, the DHCP helper-address need to be added to LAN interface. It is an IP address of the gateway in another network segment which DHCP server exists.

Wireless controller manages the distribution of DHCP pool using bridge interface. It joins two networks segment which are LAN available port and WLAN interface. When a bridge interface is created, the WLAN interface can get an IP address from the DHCP pool.

D. Smart Agent PC

The third part of the proposed system is the smart agent to capture DHCP traffic. It is put in a computer with network access to a generic router. It works as an active interface to monitor the network. Developed by a Python program and networking library. It is programmed to check every packet at interchange point between DHCP server and DHCP relay. Networking library monitors every Transfer Control Protocol (TCP) packet from upper layer with a specific filter.

E. OpenWRT Wi-Fi DHCP passive bridge

This research tests the proposed algorithms in generic wireless router available in the market. TP-LINK WR-940ND and Linksys E1200 are choosen because having client limitation and service endurance problem. Developed OpenWRT OS is then installed in each wireless router. This step improves the functionality of the generic wireless routers. It creates a bridge interface between WAN (connected to internet) and WLAN (connected to network).

III. Examination Scenarios

Overal system consists of two clients using laptop, one PC which has Phyton smart agent installed, two generic wireless routers which has OpenWRT OS modified, one Cisco Router 1 as DHCP server, two Cisco Routers 2 & 3 as DHCP relays, and one ethernet hub or switch. Figure 2 shows the default scenario of the overall system for examination purpose of the proposed smart agent and DHCP relays to support DHCP server.

The DHCP request flows as follow. Client requests DHCP information from nearest Cisco Router 2 i.e. DHCP relay 1. It forwards DHCP request to Cisco Router 1 that act as DHCP Server. Smart Python agent monitors network segment from Ethernet hub or switch that connected to Cisco Router 2 and 3 which act as DHCP relays. Cisco Router 2 is connected to OpenWRT wireless router that acts as bridge interface in DHCP direct relay scenario. When there are two

DHCP relays joined the network (in this case, Cisco Router 3) the scenario will switch to DHCP two relays scenario.

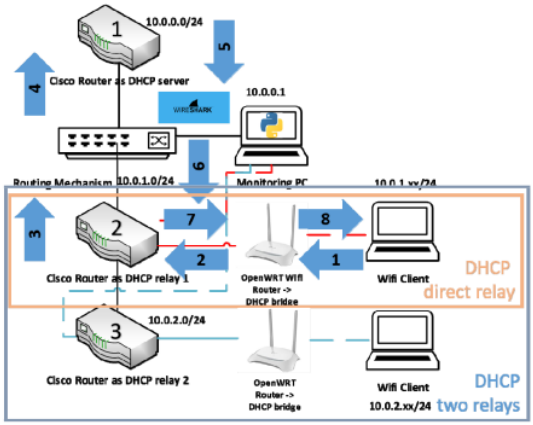

Fig. 2. Overal system in the default scenario in Cisco environment.

After the proposed algorithm is applied, smart Python agent in monitoring PC checks the memory capacity of Cisco Router 1 that acts as DHCP server. The smart agen will decide either to use old DHCP server or new DHCP server which is Cisco Router 2. Since occupancy memory of the DHCP server is less then 75%, there is no delegation to Cisco Router 2 or DHCP relay 1 to handle the DHCP request load. This scenario is illustrated in Figure 3.

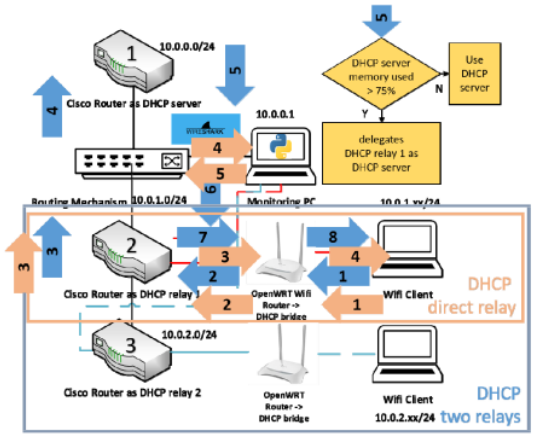

Fig. 3. Second scenario of examination when the proposed smart agent using one DHCP relay works to support the DHCP server handling the DHCP request.

The third scenario is shown in Figure 4. Here, the system is employing two DHCP relays i.e. Cisco Router 2 and 3. In this case the incoming DHCP request is forwarding to DHCP relay 2. While the DHCP information is passing through this DHCP relay 2, the smart Python agent checks the memory resources of the current DHCP server which is the Cisco Router 1. When the occupied memory of the current DHCP server is less then 75%, the smart Python agent lets this DHCP server to do the job handling the DHCP request. No delegation order will be sent to either DHCP relay 1 or 2.

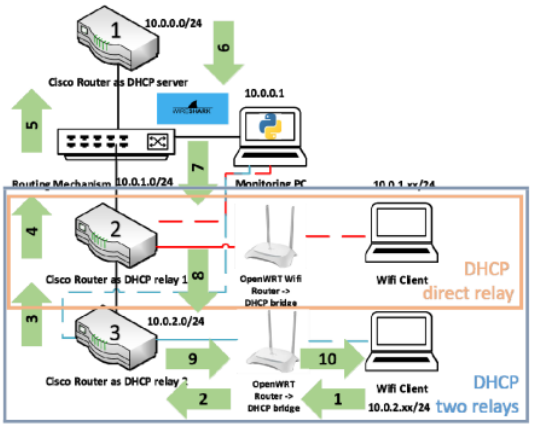

Fig. 4. Examination scenario of the proposed smart algorithm using two DHCP relays.

Figure 5 shows a situation when the smart Phyton agent notifies that DHCP server is busy and its memory is occupied more than 75%. If there is a DHCP request coming, the DHCP server will not be able to serve it. Big possibility the DHCP request will be either rejected or wait for random time and try to resend the request. Both situations are unwanted. Fortunately, by the existence of the proposed smart agent, the system can avoid those unwanted situations. After knowing this situation, the smart agent will trigger a command to delegate the Cisco Router 3 i.e. DHCP relay 2 to act as the DHCP server. It is now handling the DHCP request and provide IP address for the client.

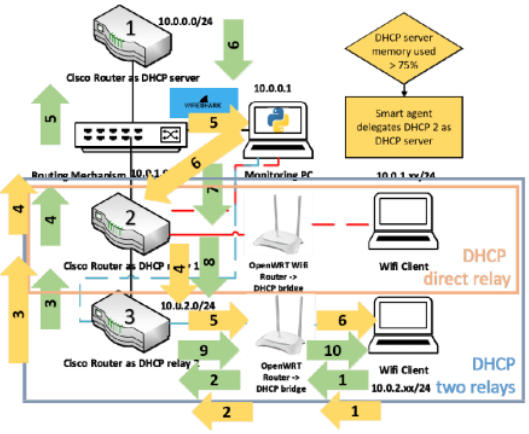

Fig. 5. Examination The proposed Smart Agent and DHCP relays when DHCP relay 2 handles the job of DHCP server.

IV. Performance Examination

There are two examination conducted to test the proposed smart algorithm. The first examination is to check the wireless router availability improvement, i.e. the number of connected clients. The second is measuring the release time of DHCP server, i.e. the durability of service. The firmware of the wireless router OS should be formatted using

OpenWRT to change it's functionality into wireless bridge interface. Without changing this functionality, the algorithm and modification could not be implemented. The functionality changing in the wireless router overcomes the availability problem in one network segment level. The modified algorithm is more expanding the availability to many network segment joined the smart DHCP system. Table I shows the comparison of the client connected and durability between the wireless router with original firmware and with modified OS plus proposed backup algorithm.

TABLE I. COMPARISON OF CONNECTED CLIENT AND DURABILITY BETWEEN ORIGINAL, OPENWRT, AND PROPOSED BACKUP ALGORITHM IN WIRELESS ROUTER

DHCP Mode	OS Mode	Connected client	Endurance (days)
Wireless router as direct DHCP server	Firmware	13 - 15	+/- 1
	Modified OpenWRT	253	> 1
Cisco act as DHCP server and Wireless router act as DHCP bridge	Modified OpenWRT + Proposed Algorithm	253 x n	> 2
n = number of connected network segment			

Table 1 shows that there is an increasement in number of connected client as well as the durability, especially when using OpenWRT as a modification of wireless router OS. Further, by adding the proposed algorithm to the OpenWRT OS, the number of connected client improved, as expected. It depends on how many network are connected, with the number of client in a network segment remains the same.

The next parameter to be examined is the DHCP release time, i.e. the time needed by the system from the DHCP requested package until the client get the IP address. Two scenarios are set onto two kind of SOHO wireless router. First scenario is Cisco Open WRT with Direct DHCP and second scenario is Cisco Open WRT with Relayed DHCP. It was about 100 trials conducted for each scenario shown in Figure 2. However, due to space limitation, in this paper Table II only shows four samples of them.

TABLE II. RELEASE TIME COMPARISON BETWEEN OPENWRT + DIRECT DHCP AND RELAYED DHCP IN CISCO ENVIRONMENT

Trial	Cisco OpenWRT + Direct DHCP	Cisco OpenWRT + Relayed DHCP
1	2.79	2.74
2	2.80	2.76
3	2.74	1.96
…	…	…
100	2.89	2.88
MIN	2.74	1.96
MAX	2.89	2.88
MEAN	2.81	2.78
VAR	0.03	0.07

These values show that DHCP release time is slightly decreased due to the existence of a relay. However the variance (VAR) different between direct DHCP and relayed DHCP is only about 0.04 seconds, which can be neglectable. There was an interesting fact when doing this test. Usually, when the number of DHCP's relay increases, the release time increases, but in here the release time decreased by the existence of the relay. The VAR value of DHCP relay which was higher than DHCP direct showed that gaining IP address from the relay was not stable. However, it did not affect the release time as a performance parameter. This result is inline with previous research which conducted under simulation [1] It was shown that relayed DHCP was faster compared to direct one.

V. CONCLUSION AND FUTURE WORK

Examination of the proposed simple smart algorithm to enhance the flexibility of dynamic allocation DHCP server for SOHO wireless router under Cisco environment has been conducted. The old series of these devices are now enhanced. They are able to serve more than 10 times connected clients compared to using the original firmware. They also have more than twice longer service time duration. Future work will be updating the proposed algorithm to include the security issue to prevent DHCP starvation attack by detecting the pattern of the incoming package.

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REFERENCES

[1] W. A. Syafei, Y. A. Adi Soetrisno, and A. B. Prasetijo, "Smart agent and Modified-Backup Algorithm for Auto Switching Dynamic Host Configuration Protocol Relay through Wireless Router," International Journal of Communcation Network and Information Security (IJCNIS) Vol. 12, No. 2. August 2020 pp. 248 – 255. ISSN: 2076-0930 (Print). 2073-607X (Online)

[2] Bauer, Steven and Clark, David D. and Lehr, William, Understanding Broadband Speed Measurements (August 15, 2010). TPRC 2010. Available at SSRN: https://ssrn.com/abstract=1988332.

[3] Y. Guo and Z. Li, "WLAN Based Wireless Self-Organization Link: Research and Realization," in 2017 International Conference on Computer Network, Electronic and Automation (ICCNEA), Xi'an, Sep. 2017, pp. 268–271, doi: 10.1109/ICCNEA.2017.99.

[4] S. K. Hooda, A. Ghule, V. Puneet, and A. Indiresan, "DHCP in Layer-3 Overlay with Anycast Address Support and Network Address Transparency," U.S. Patent 10,454,882, Oct 22, 2019.

[5] C. Miao et al., "BDAC: A Behavior-aware Dynamic Adaptive Configuration on DHCP in Wireless LANs," in 2019 IEEE 27th International Conference on Network Protocols (ICNP), Chicago, IL, USA, Oct. 2019, pp. 1–11, doi: 10.1109/ICNP.2019.8888048.

[6] A. Singh, R. K. Arehalli, and S. B. Suryananarayana, "System and Method for Minimizing Broadcast Communcations when Allocating Network Address," U.S. Patent 10,375,014, Aug 6, 2019.

[7] L. Trombeta and N. Torrisi, "DHCP Hierarchical Failover (DHCP-HF) Servers over a VPN Interconnected Campus," Big Data and Cognitive Computing, vol. 3, no. 1, p. 18, Mar. 2019, doi: 10.3390/bdcc3010018.

[8] T. M. F. Pang, B. Yang, M. N. Kamath, and X. Zhou, "Dynamic Orthogonal Local DHCP IP Pools for Wireless Access Points," U.S. Patent 2019/0281011, Sep 12, 2019.

[9] R. A. Alhanani, J. Abouchabaka, and R. Najat, "CDS-MIP: CDS-based Multiple Itineraries Planning for mobile agents in a wireless sensor network," in International Journal of Communication Networks and Information Security (IJCNIS) vol. 11, no. 1, p. 10, 2019.

[10] A. Abdellaoui, J. Elmhamdi, and H. Berradi, "Multipoint Relay Selection based on Stability of Spatial Relation in Mobile Ad hoc

[11] A. Pourghaffari, M. Barari, and S. Sedighian Kashi, “An efficient method for allocating resources in a cloud computing environment with a load balancing approach,” Concurrency and Computation: Practice and Experience, p. e5285, Apr. 2019, doi: 10.1002/cpe.5285.

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