Dynamic Tunnel Switching using Network Functions Virtualization for HA System Failover

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Dynamic Tunnel Switching using Network Functions Virtualization for HA System Failover

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***Abstract*— High Availability (HA) is an ability of the system to operate continuously in desired amount of time. Telephony system, for example, should operate 99,999%, that means the system should have only 5.26 maximum downtime for a year. Provide high available IP based service such as Voice over IP for telephony is difficult since IP is not designed for reliable connection. A lot of research has been conducted to overcome these drawbacks. This paper works by enhancing the failover mechanism of Remus as a high availability solution using server virtualization. This paper used network function virtualization in order to create a dynamic tunnel, switching between primary and secondary server to the clients gateway. The result shows that the server downtime using dynamic tunnel, switching was varied between 1.3 - 1.5 second. This result is still comparable with basic Remus downtime with gratuitous ARP. This paper extends the ability of failover to adapt the wide area condition.**

Keywords—high availability; failover; NFZ; virtualization; Remus

I. INTRODUCTION

Nowadays, the internet became one of main humans need in their daily life. Downtime of a service is one of the modern human nightmare. In order to support the service uptime, well know as high availability, a lot of research has been conducted. IP based service is believed will be the future generation of various services exist nowadays. A lot of service has been provided their service in to IP based, i.e telephony, television. However, those emerging technologies have to fulfill the availability standard. A highly available of telephony system, for example, should operate for the 99,999 %, that means the system should have 5.26 maximum downtime for a year. This availability of telephony system well known as five-nine rules.

Provide highly available of Internet Protocol (IP) based service is more difficult. In fact, IP is not designed for reliable connection. Virtualization has then become a popular technique for cost reduction and hardware efficiencies and also to support HA. Server virtualization and network function virtualization (NFV) is used for more scalable and efficient networks function. Virtualizations are believed to be a key of IP based service to deliver high availability connection. High Availability service using server virtualization has been studied. Continuous live migration of a virtual server is introducing to make the server more high available. However, this emerging technology needs more improvement for scalability. Scalability improvement using network function virtualization of high availability server in order to support failover is conducted in this paper.

II. RELATED WORKS

Virtualization of server for high availability using continuous live migration processes in LAN environment is conducted in paper [1]. The works explain briefly how the Remus high availability is provided by enhancing the live migration process of virtualized server continuously. If the primary server is failed the failover will occur and secondary server would take the service request without disruption. The process is application transparent and the service is still available with minimal downtime. If the primary server is available the synchronization will occurs and failback mechanism may happen.

Scalability and performance of high availability using Remus are two of the main drawbacks that need to be improved. The failover mechanism only works in local area networks since it is using gratuitous ARP packet to announce the running server. The work on [2] studied the Seamless live migration over Metropolitan Area Network (MAN) and Wide Area Network (WAN). Paper [3] explained the failover live migration process in wide area environments using dynamic Domain Name Server (DNS). Both papers only studied the failover live migration. The work on [4] studied the continouse live migration and proposed Border Gateway Protocol (BGP) update to announce client the new path after failover.

Paper [5] describe the state of the arts NFV that help companies to reduce capital expenditures (CAPEX) and operating expenditures (OPEX) by using virtual networks instead of dedicated hardware. The works also stated that leading telecommunication companies support and belief that NFV is one of the main key of future telecommunication technologies. Paper and standard [6,7] works on the use cases of NFV on the wireline access networks and also the NFV

standard landscape. The works describe several cases of how the NFV could help driving a transition towards future programmable carrier grade networks.

The work in [8] studied the HA system of VoIP server failover mechanism over WAN. The paper also proposes dynamic tunnel switching for traffic redirection and measured the downtime and voice quality. However, the works still using traditional ways to create the interfaces and bridges. This paper improves the dynamic tunnel switching using network function virtualization for better network management process.

III. HIGH AVAILABLITY SYSTEM VIRTUALIZATION

High Availability (HA) is an ability of the system to operate continuously in desired amount of time. Availability of system is usually expressed as a percentage of uptime in a given year. The reason for the unavailability of systems were varied i.e. hardware maintenance or failure, network failure, server down. Therefore, to deliver a highly available system is difficult and expensive. Remus [1], a Xen virtualization extension proves that virtualization is one of emerging technology in order to support high availability.

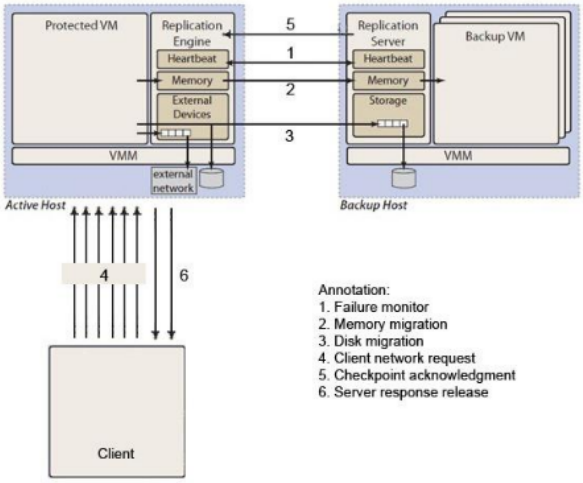


Fig. 1. Remus High Avalability Works [1]

Figure 1 depicts how Remus works by doing the continuous live migration process iteratively. Each copy of running server (primary server) is copied to secondary server periodically called as a checkpoint. If the problem occurs on primary server that made the service unavailable, then secondary server will take over the service request in minimal downtime with its last checkpoint states. The work in [9] made some improvement to Remus buffering rules and studied the impact to make its feasible to runs realtime IP based service such as Voice over IP. Those works results show that high available system using Remus is feasible to deliver high availability IP based service.

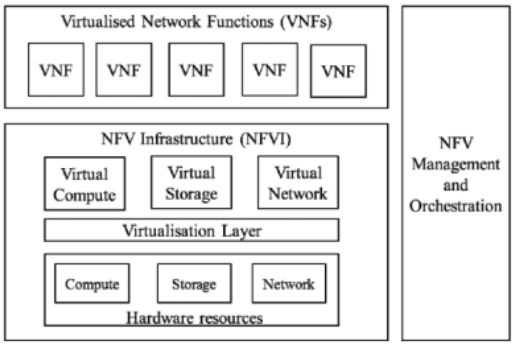


Fig. 2. High-level NFV framework [10]

Besides server virtualization, network virtualization also improves the hardware based network deficiencies. Network function virtualization becomes popular and a lot of big network companies upgrade their products with these new emerging technologies. Figure 2 depicts the ETSI high level NFV framework. The figure shows the relation of hardware resources, virtualization layers/hypervisor and virtualised network function that runs on top of it. NFV management and orchestration is used to manage and control the virtual network functions.

IV. SIMULATION AND RESULT

Dynamic tunnel switching is implemented using NFV. The idea is to create a tunnel between primary and secondary server and also to the client gateway. The Tunnel is used to improve the failover mechanism for more scalable implementation. The scenario is depicted in figure 3.

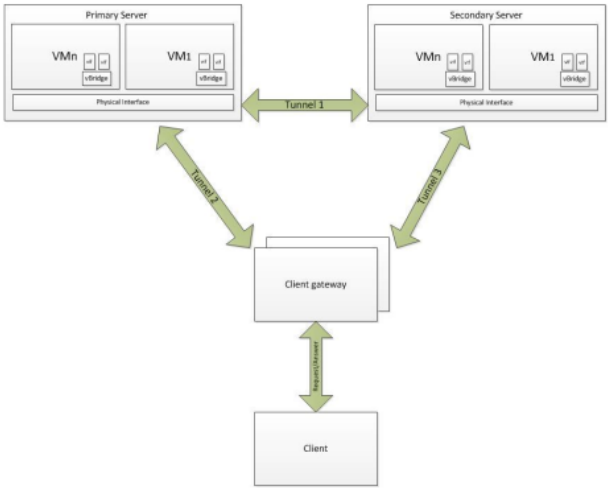


Fig. 3. Tesbed

Openvswitch is used to deploy virtual interface, bridge and GRE tunnel feature is used. Since only Xen XCP tool stacks natively support Openvswitch, therefore Xen with xm or xl tool stack is needed a modification to be able to working with Openvswitch. The scenarios will work as stated in the algorithm follow :

Algorithm :

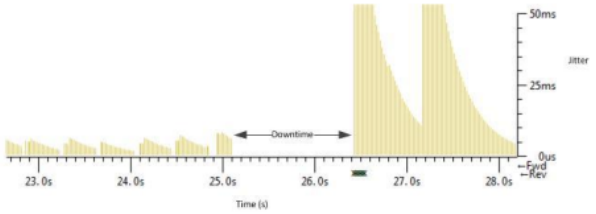
```
begin
{
Repeat;
{
Check running server;
if
(running server = primary)
then
add tunnel 2, remove tunnel 3;
}
else
{
add tunnel 3, remove tunnel 2;
}
}
```

Tunnel 1 is used for continuous live migration of a virtual machine link from the primary to the secondary server in order to create a high availability. Tunnel 2 and 3 is used for the client access channel, only one of tunnel 2 and 3 is up at the same time depends on which server is running the service. Remus needs to modified to be able to run the dynamic tunnel switching. Failover mechanism will resume the paused virtual machine on the secondary server and immediately notify the client gateway if primary server become unavailable. The dynamic tunnel switching is used to guide the data packet to which server is active to serve the client request with minimal downtime. If the primary server is available again the synchronization will occurs and failback mechanism may happen repeat the dynamic tunnel switching process.

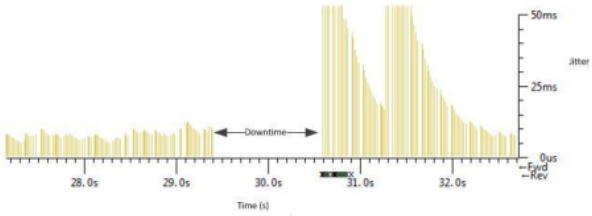
Jitter calculation is considered to present the result. Jitter is calculated using interarrival jitter (J) and mean deviation of the difference (D) defined for pairs packet as shown on equation 1 [17].

$$J(i) = J(i-1) + \frac{(|D(i-1,i)| - J(i-1))}{16} \qquad (1)$$

Figure 4 depicts the jitter graph both for original high availability using Remus and modified using dynamic tunnel switching. The figure shows the jitter level and amount of time when the packet is buffered due to service downtime. The result shows that the jitter level and downtime of modified failover using dynamic tunnel switching did not make the jitter or amount of downtime higher. The comparison of original and modified downtime result is presented in figure 5. The Remus checkpoint does not have an effect to the downtime.



(a)



(b)

Fig. 4. (a) Jitter and downtime of original failover
(b) Jitter adn downtime of modified failover

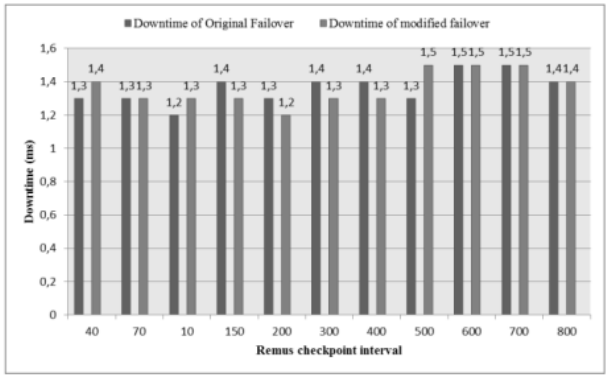


Fig. 5. Measured downtime

FUTURE WORKS

For the future works we consider deploying Software Defined Networks (SDN) for NFZ orchestration. However, this approach should consider how to integrate the orchestration process with Remus.

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