Statelet-Based Efficient and Seamless NFV State Transfer

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Network Function Virtualization (NVF) is a concept which allows users to operate network related services and precisely monitor the network traffic with Software Defined Network (SDN).Main approach is for consistent and improved NVF state transfers using statelets.Statelet (packets)are used to modulate the virtualized network functions(VNF).An instances of VNF placed on NVF which can be transferred from one physical node to another to reduce network trafficking.SliM migration system (SliM) is introduced for efficient state transfer/network management which proposes one third of the reduced duration rate.

1 Introduction

NVF provides flexible and improved network architecture. Migration techniques are used to provide properties like elasticity, flexibility for better state migration. VNF migration mechanism requires smooth transfer, so that customer does not receive any network service issues. While transferring these instances some issues come under the process like packet loss, bandwidth requirements, network traffic etc. To address these problems statelet approach[**2**] (Compact representation of packets information) has introduced. SliM system analyzes this approach and implement statelet-based mechanism. For system implementation and installation authors use DPDK library, so developers can adopt beneficial features and can increase the performance rate.

2 Approach and Implementation : Statelet Interface

Authors main goal is to transfer the NVF states (which is based on statelet) with less bandwidth requirement and delay. In previous approaches methods were bigger and time consuming ex. Open NF with peer to peer transfer which is also called as Duplication based mechanism, in this mechanism Open NF allows network function to completely or partially transfer its state to other resources using duplicate packets i.e duplicate packets with irrelevant information, which can cause packet buffering, VM live migration technique, in this technique bandwidth requirement is inadequate, can cause traffic in network. Considering all these previous methods, Author chose statelet based transfer approach because of its advantageous features. According to current statelet interface, it is considered as **variable-length byte vector**, so statelet can be empty(just announcing packet event) or can neglected it(no data related packet). In this how NVF can use the statelet interface to avoid trafficking in network by using following methods.

Network address translation:

Track entries of packets, store those byte and packet counters which contains information that has to be transferred.

Signature-based intrusion detection:

keeps the information related previous harmful content in packets, so future harmful attacks can be prevented.

Vpn concentrator:

keeps the track of number of packets so for genuine customers, if there is any change in related information (statelet), only that statelet can be called.

Using all these statelet-based methods,state transfer can be smoothly done without packet buffering and insufficient bandwidth requirements.Authors prove that statelet interface is an innovative approach which does not require any extra packet size for state update, so less bandwidth and less time consuming. If in case in extreme condition redundancy problem (statelet is larger in size than packet,as it should be smaller than packet) can occur, which can be solved using large overhead computation. [**1**].

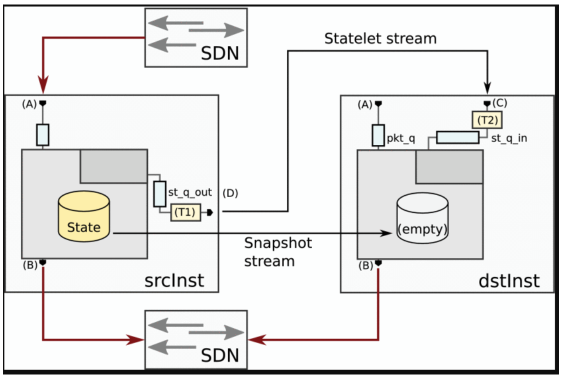

Figure 1: Dataplane during migration procedure before traffic redirect[**3**]

3 System Model

This part includes methods of slim migration system, as VNF migration architecture.How it has been used with statelet-based approach, has described. Migration is performed from source to destination instance and has divided into two parts **partial**(that is fraction of state migrates) and **complete**(fully state migrates) VNF migration. SliM Controller starts the destination environment, source instance allows reliable transmission of snapshot and **statelet**. This statelet transmission goes until snapshot has fully received.Following operations are used for Migration procedure.

1. **State Migration Procedure**

   Shows components in datapath state migration before and after redirect traffic do destInst. Figure 1 explains datapath components in migration procedure before traffic redirect to destInst. Controller makes sure that destInst destination is ready on destination hypervisor, then that states and packets are set at destInst. They only add statelets and don't pass them to VNF application or delete. After that srcInst connects to destInst using TCP protocol and send data streams it updates flag and allow statelets to enter and take snapshot of them. These snapshots send to the snapshot stream and then thread closes itself. After this synchronization thread takes the snapshot and install it to destInst if thread observes state in has reached to the destInst it sends redirect message to the controller and now packets will enter after switchover and will wait for round robin manner. Figure 2 shows after getting redirect message it enables redirect flow of srcInst data input to destInst and cannot operate if there are still statelets in srcInst.

2. **Mutual Exclusion**

   Mutual exclusion between datapath and synchronization of actions on state[**1**].Here statelets are installed before dataplane operations start.

3. **Extending to Partial State Migration**

   Split and merge operations(per-flow state smoothly split as replicas or merge as one replica) transfer for seamless VNF state transfer.Partial state migration is good for large scale operations. VM can cancel the state which is not useful for destInst (split) and can extend the state. Split operation does not require much modifications to complete migration while merge technique needs modifications or can go under certain condition.

4 Analysis

State migration is bandwidth limited to solve this problem and to analyze its other requirements "statelet factor" has included. Main focus is on migration complete time (successfully), bandwidth usage and **statelet factor** σ. Statelet factor describes ratio of average statelet traffic volume caused by

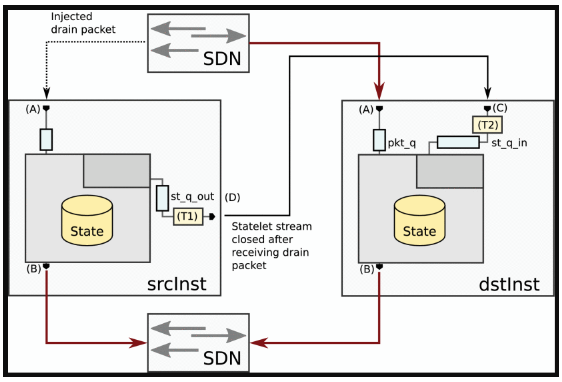

Figure 2: Dataplane during migration procedure after traffic redirect[3]

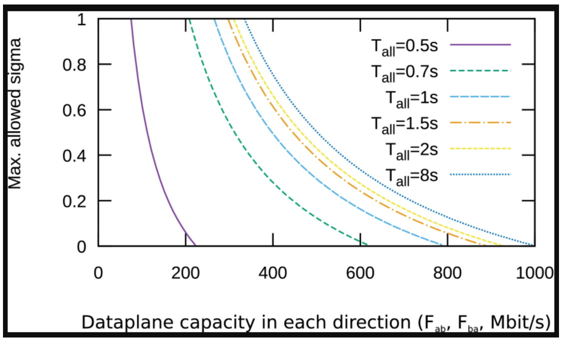

Figure 3: Dataplane capacity in each direction(Mbits)[3]

packets transfer and total packets itself. According to statelet factor size of the snapshot is selected and transferred (checks dataplane capacity). Figure 3 shows dataplane "capacity in each directions", maximum allowed statelet factor in graph is plotted at 100M(bits/seconds). Snapshot size was considered 20M Byte. This graph shows migration times to all, all curves in the graph touches the X axis where there is very less bandwidth to transfer the snapshot. However packet duplication (σ=1),as bandwidth utilization is three times the statelet.

5 Evaluation

Evaluation setup is explained using Data plane development kit, which is utilized for dataplane interfaces to reduce stack overhead and to use its other features to manage interfaces. Implemented proof-of-

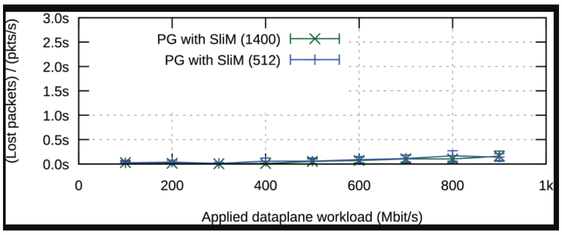

Figure 4: Seconds of loss,PG NF[3]

concept on NFVI(key component of NFV architecture) hypervisor(which is used to describe software and hardware components on Virtual Networks). Hardware and Virtualization architecture also used for evaluation setup.

6 Results

For seamless transfer two main characteristics are observed packet loss and delay which can affect the migration. Figure 5 and Figure 4 describes packet loss in "seconds of loss" Metric shows the total number of packets loss during one instance migration divided by the current packet rate per seconds, this shows packet loss between different dataplane workloads. Figure 6 shows seconds of RTT larger than 15ms, which includes the packets enter late after 15ms. For the NAT NF, both duplication mechanism and SliM gives lower loss at lower rates. At 300M(bits/seconds) duplication starts lowering for both packet sizes, while SliM gives better rates, at 900M SliM also starts degrading its performance. Figure 7 presents total duration of migration for one instance, where SliM completes in third of the time of duplication at high data rates. Migration duration is less than 1s for 100M. Duplication Mechanism consumes more time with increasing workload and it goes till 5s at 800M however SliM still completes in less than 1s. According to the results it depicts that compared to Duplication, SliM reduces the traffic rate and provides better performance rate.

7 Conclusion

Authors concluded that SliM technique is bandwidth efficient which only transfers packets(information) that is essential for synchronization. Compared to

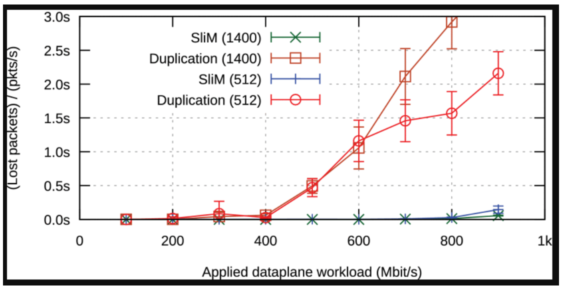

Figure 5: Seconds of loss NAT NF[**3**]

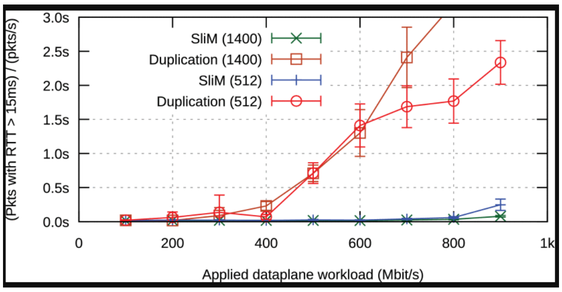

Figure 6: Seconds of RTT larger than 15ms (latency)[**3**]

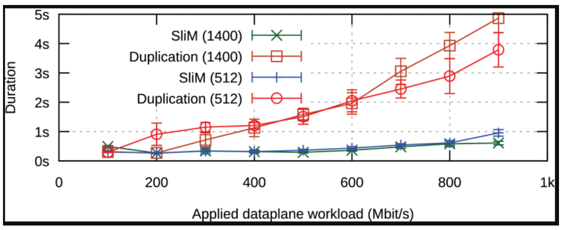

Figure 7: Migration Duration for 1400-Byte and 512-Byte packets NAT,NF[**3**]

previous approaches like Duplication Based Mechanism, SliM provides higher performance rate and reduces packet loss and it is synchronized for two or more instances.

8 Future Work

Future plan is to extend SliM with partial state migration and performing for large scale operations on bigger platform like OpenStack. Show SliM with its feasibility in different types of ways (additional ways) ex. In order to decrease delay and jitter, migration time during switchover operations

References

[1] Gember-Jacobson et al. *"OpenNF: Enabling innovation in network function control"*. Proc. SIGCOMM, pp. 163-174, 2014.

[2] L. Nobach, I. Rimac, V. Hilt and D. Hausheer. *"SliM: Enabling efficient seamless NFV state migration"*. Proc. ICNP, pp. 1-2, Nov. 2016.

[3] L.Nobach, I.Rimac, V.Hilt and D.Hausheer. *"Statelet-Based Efficient and Seamless NFV State Transfer"*. In IEEE Transactions on Network and Service Management, vol.14,no.4, pp.964-977, Dec 2017.