Statelet-Based Efficient and Seamless NFV State Transfer

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Summer term 2020

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 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 needs 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 (Duplication based mechanism-can cause packet buffering),VM live migration technique (memory difference, packet duplication) can cause traffic. According to current statelet interface, it is considered as **variable-length byte vector**. 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 which has to 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.

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) can occur, which can be solved using large overhead computation. [1].

3 System Model

This part includes methods of slim migration system, as VNF migration architecture. Migration is performed from source to destination 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 methods are used.

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**

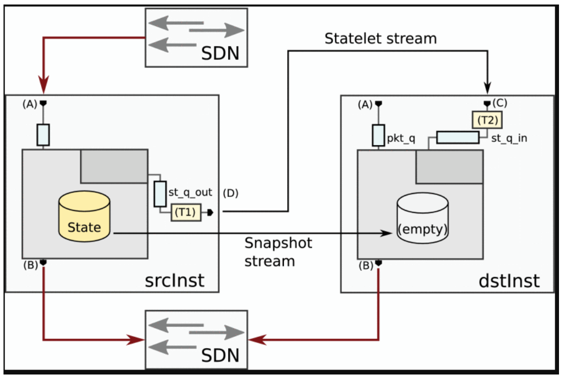

Figure 1: Dataplane during migration procedure before traffic redirect[3]

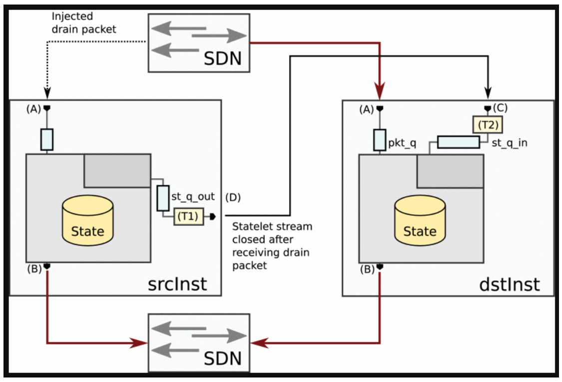

Figure 2: Dataplane during migration procedure after traffic redirect[3]

   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 mi-

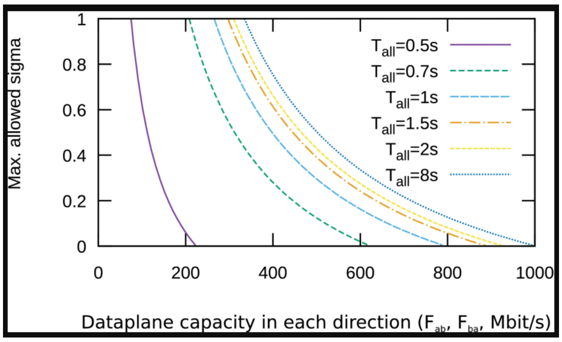

Figure 3: Dataplane capacity in each direction(Mbits)[**3**]

gration complete time (successfully), bandwidth usage and **statelet factor** σ. Statelet factor describes ratio of average statelet traffic volume caused by 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

Data plane development kit is utilized for dataplane interfaces to reduce stack overhead and to use its other features to manage interfaces. Implemented proof-of-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 used for evaluation setup (shows bidirectional flow).

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

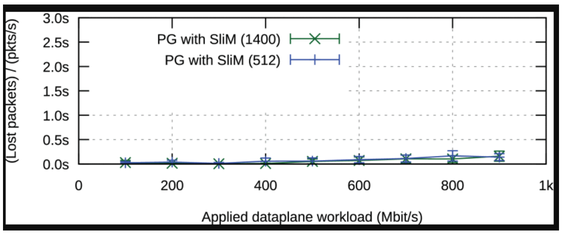

Figure 4: Seconds of loss,PG NF[**3**]

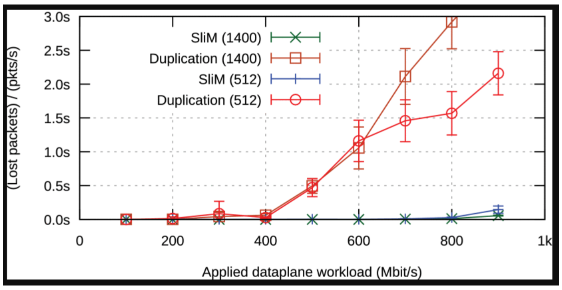

Figure 5: Seconds of loss NAT NF[**3**]

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 transfer packets(information) that is essential for synchronization. Compared to previous approaches like Duplication Based Mechanism, SliM provides higher performance rate and

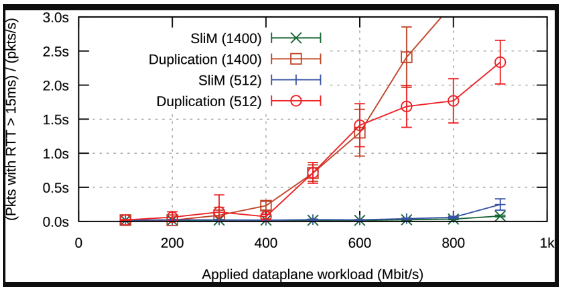

Figure 6: Seconds of RTT larger than 15ms (latency)[**3**]

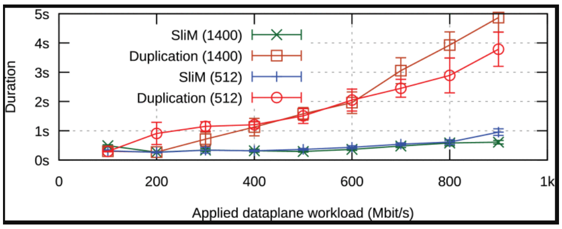

Figure 7: Migration Duration for 1400-Byte and 512-Byte packets NAT,NF[**3**]

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.