PRAM: Priority-aware Flow Migration Scheme in NFV Networks

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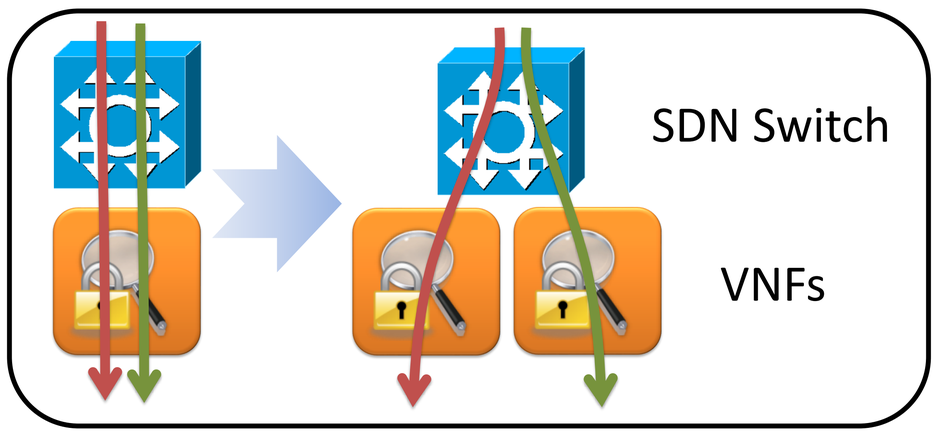
❖ *Motivation*: Optimizing Flow Migration in NFV by *Differentiating Flows*



Flow Migration (NF scale-out)

High Latency Sensitive Flow (e.g. stock trade flows)

Low Latency Sensitive Flow (e.g. P2P downloading flows)

Migrating low latency sensitive flows could introduce fewer SLA violations!

How to migrate flows?

- Split/Merge [NSDI '13]
- OpenNF [SIGCOMM '14]
- TFM [ICNP '16]

Which flows to migrate?

❖ *Solution*: *Priority-aware* and *Size-aware* Flow Migration Selection Scheme

Optimization Objective

$$\min \sum PWMT = \sum x_i p_i t_i \quad \text{s.t.} \sum x_i s_i > S_{mig}$$

- select enough flows to alleviate the VNF load
- migrate lower latency sensitive flows (less SLA violations)

PWMT (Priority-Weighted Migration Time)

- The product of ***migration time (t_i)*** by the ***flow priority (p_i)***.
- Measures the impact of migration on these flows.

Indicator $x_i \in \{0,1\}$: Indicate whether flow i is migrated.

S_{mig}: the total ***flow size (s_i)*** to migrate.

Observation 1: *The migration time for each flow increases linearly with the number of flows to migrate in total.*

Observation 2: *The migration time for each flow is irrelevant to the flow size.*

$$t_1 = \cdots = t_N = A(\Sigma x_i) + B$$

*A and B are two constants only related to VNF itself

Optimization Objective

$$\min \ (A \sum x_i + B) \sum x_i p_i \quad \text{s.t.} \sum x_i s_i > S_{mig}$$

0-1 Integer Programming ✗

- Slow (NP-hard)
- Unacceptable to enable dynamic flow migration

SP2-Greedy Algorithm ✓

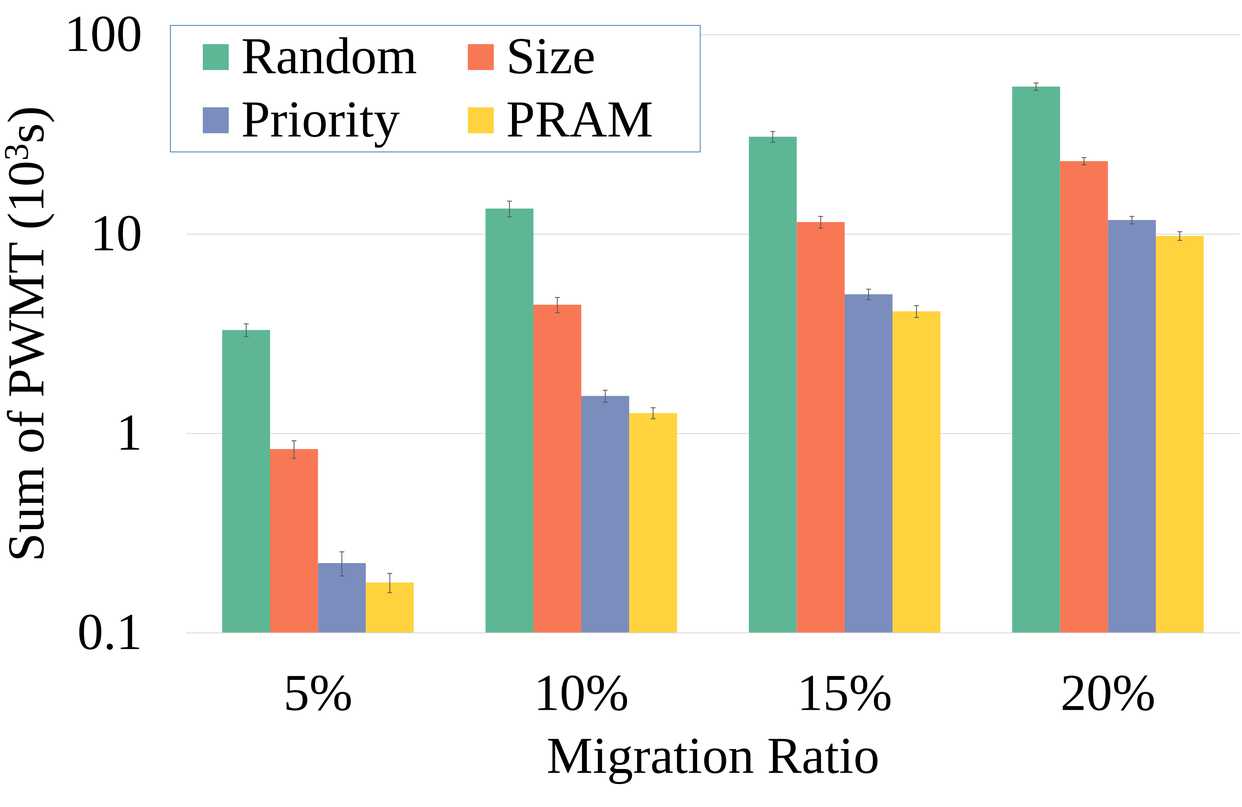
Size Per Priority (SP2): s_i / p_i.
Higher *SP2* -> flows with *lower priority* and *larger size*.

Step 1: Parameters initialization
We calculate the *SP2* of each flow in the VNF.

Step 2: Flow Migration
As our greedy strategy, we pick the flow with the highest *SP2*.

Step 3: Flow size fulfillment
PRAM checks whether enough flows have been selected to migrate (Size of flows that have been selected should be larger than S_{mig}). If not, the algorithm goes back to Step 2. The cycle continues until enough flows have been selected for migration.

❖ *Evaluation*: PRAM *vs.* Random/Size-greedy/Priority-greedy Selection



Migration Ratio: S_{mig}/(total flow size on a VNF)

Simulation Details:

Flow Size: Distribution in the datacenters [3].

Priority: Randomly from 1 to 100 with uniform distribution.

Use MATLAB to do simulations of 1,000 flows for 20 times.

PRAM reduces the sum of PWMT by:

vs. \ Migration Ratio	5%	10%	15%	20%
Random Selection	18.48x	10.61x	7.51x	5.61x
Size-greedy Selection	4.67x	3.48x	2.80x	2.37x
Priority-greedy Selection	1.25x	1.22x	1.22x	1.20x