ComputerScience

Boston University

Managing NFV using SDN and Control Theory

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What is RINA? [1][2][3]

- RINA: Recursive InterNetwork Architecture
- A clean-slate network architecture that overcomes inherent weaknesses of the current Internet, e.g. security, mobility support
- Based on the fundamental principle that *networking is Inter-Process Communication (IPC) and only IPC*
- Distributed IPC Facility (DIF): a collection of distributed IPC processes with shared states. They provide communication service to application processes over a certain scope (i.e., range of operation)
- Distributed Application Facility (DAF): a set of application processes cooperating to perform a certain function. The function can be a communication service, weather forecast, genomics, *etc.*
- Two design principles: (i) divide and conquer (recursion), and (ii) separation of mechanisms and policies

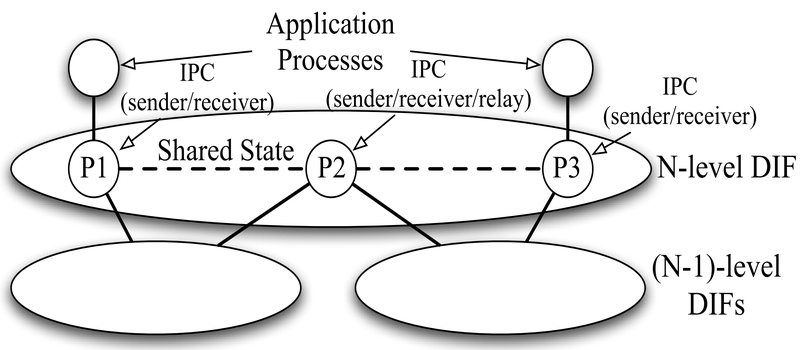

Fig. 1: RINA overview

Control Theory, SDN and NFV

- Control theory and SDN are key components for NFV deployment
- RINA management architecture is used to manage Virtual Network Function (VNF) instances over the GENI testbed
- Control theory (PI controller) is used to balance load across different VNF instances

Experiment over GENI

- Experimental setup (Fig. 2):
  - two VNF instances running Snort IDS (*VNF1* and *VNF2*)
  - one OVS switch and one open-flow controller
  - two sources (*S1* and *S2*) and one destination (*destination*)
- Traffic is sent to Snort-IDS running on *VNF1* or *VNF2*
- RINA management architecture is used to send load of VNF instances to controller
- Load balancer determines the fraction of traffic to divert from VNF1 to VNF2
- OVS controller updates openFlow rules on the OVS switch

Load Balancer

- PI controller (Fig. 3):

$$x(t) = \max[0, \min[1, x(t-1) + K(\frac{L(t)}{T} - 1)]]$$

$x(t)$: ratio of traffic diverted to VNF2 at time t

$L(t)$: load on VNF1

T: target load on VNF1

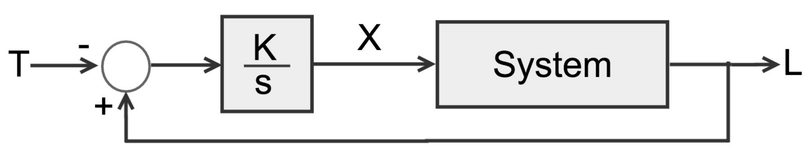

Fig. 3: System load $L(t)$ and target load T of VNF1 is used to compute $x(t)$, i.e. ratio of traffic diverted to VNF2

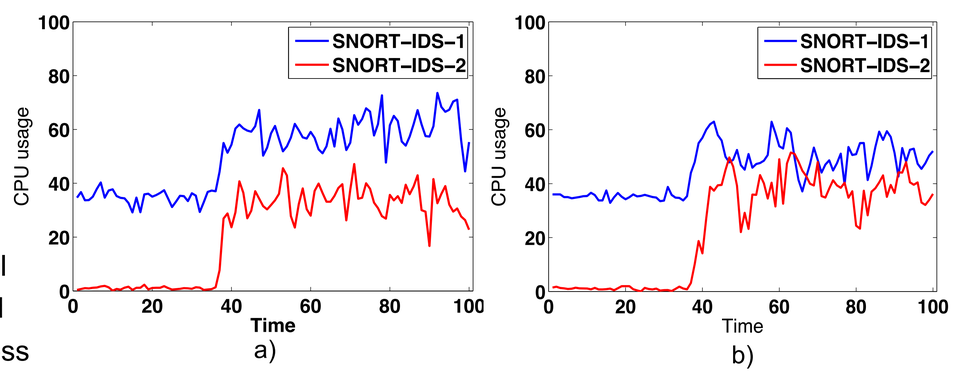

Fig. 4: (a) Simple Round Robin load balancing; (b) Load balancing based on PI control (T = 50%)

Management Architecture

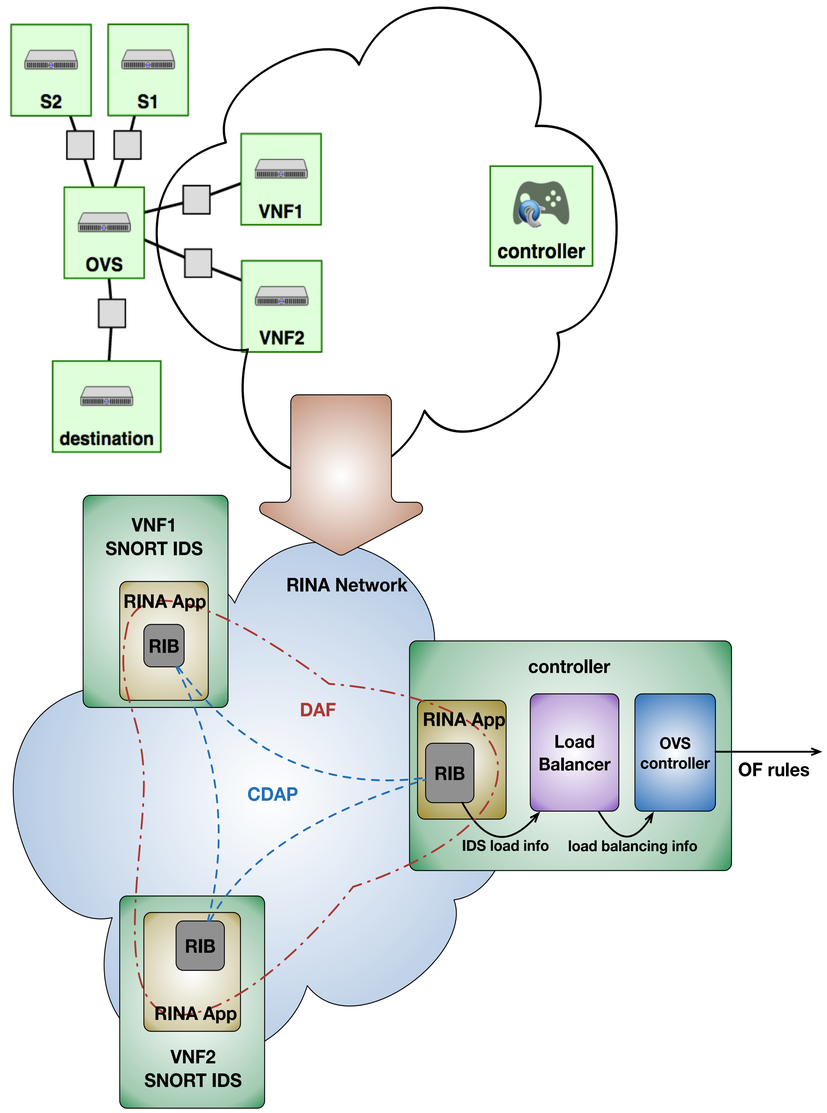

Fig. 2: RINA management architecture used for communication between VNF instances and Controller

References

[1] John Day, Ibrahim Matta and Karim Mattar. “Networking is IPC: A Guiding Principle to a Better Internet”. In ReArch 2008.

[2] Boston University RINA Lab. http://csr.bu.edu/rina

[3] Yuefeng Wang, Ibrahim Matta, Flavio Esposito and John Day. “Introducing ProtoRINA: A Prototype for Programming Recursive-Networking Policies.” In ACM SIGCOMM CCR, July, 2014.