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

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):
  \[
  x(t) = \max[0, \min[1, x(t-1) + K(L(t) - T)]]
  \]
  \[x(t): \text{ratio of traffic diverted to VNF2 at time } t\]
  \[L(t): \text{load on VNF1}\]
  \[T: \text{target load on VNF1}\]

Management Architecture

- PI controller (Fig. 3):
  \[
  x(t) = \max[0, \min[1, x(t-1) + K(L(t) - T)]]
  \]
  \[x(t): \text{ratio of traffic diverted to VNF2 at time } t\]
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Fig. 2: RINA management architecture used for communication between VNF instances and Controller

References