Service Function Chaining for In-Network Computation

Current practices: Centralized control infrastructure

Problems:
- Single Point of Failure
- Scalability
- Legacy Interoperability
- No Incremental Deployment
- Under exploitation of in-network resources

Proposal: Augment the IGP and make it function aware
Proposed approach: Divide & Conquer

Centralized Management and Orchestration (MANO)

Distributed MANO
Exploiting the existing in-network resources

If you have a large network you have an IGP (Interior Gateway Protocol)
Announced address are actually VNF

Idea(s): Binding a prefix to a specific function
Leveraging on anycast addressing

Idea(s): Binding a prefix to a specific function + Anycast Addressing

Advantages
- Prefix to select the function
- IGP metric to select the function instance
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Augmenting network layer routing

Augmented IGP topology:
- Service mapped to an anycast prefix
- Node advertise available service
- Routing decision taken with shared topology
- Routing decision is applied per flow
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NFV Router Architecture & Implementation

- **Virtualization**
- **Namespaces**
- **Encapsulation**
- **Routing**

**D-MANO**
- Ressource Monitor
- VNF Routing Algorithm
- Route Injector

**Network**
- **NSH** *(RFC 8300)*
- **IGP**
- **OSPF**

**Router**

**Connector**

**VNF 1** ... **VNF n**
Highlights on evaluation results

- **Network emulation:**
  - NFV Routers ⇒ LXC container
  - Deployed on 48 nodes cluster
  - 10 VNF (nodes with max betweenness centrality)

- **Routing policy:**
  - Shortest Path to next VNF
  - Hop-by-hop routing

- **Load balancing on VNF**

The higher LSA update frequency, the higher the network traffic distribution stability.

Source: https://sites.uclouvain.be/defo/

### Topology Distribution

<table>
<thead>
<tr>
<th>Topology</th>
<th>Nodes</th>
<th>Edges</th>
<th>Demands</th>
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<td>2449</td>
<td>Synthetic</td>
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</tbody>
</table>
What did we achieve?

- **Fully distributed framework to chain in-network function**
  - No need to rely on fast responses from a controller => Resilience, Scalability
  - Load balancing between VNF instance
  - Interoperability with legacy network => No need of SDN architecture, may rely on distributed routing protocol like OSPF
  - No configuration needed for adding new VNF instances

- **Future Work**
  - Inter-Domain Service Provisioning
  - VNF metrics
  - Maintenance and Failure
  - VNF Provisioning

References:
https://hal.archives-ouvertes.fr/hal-01889856v1
https://hal.archives-ouvertes.fr/hal-02165785v1
Backup slides