Multi-domain Service Function Chaining with ALTO - 00

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Document in a nutshell

❖ This document focuses on how the **Application Layer Traffic Optimization (ALTO)** protocol can be used to **advertise and discover abstract topology, resource and service information from different domains**, and then compute inter-domain service function paths.

❖ Another important concern of this draft document is to initiate a discussion (ALTO, SFC as well as other WGs) regarding **if, how, and under what conditions ALTO can be useful** to improve the multi-domain SFC process.

Multi-domain Approach

Building a complete end-to-end network service requires stitching services offered by **multiple administrations or multi-domain single administrations**.

- **Market Fragmentation:** Multiple Administrations
  - Having a **multitude of telecommunication networks and cloud operators** each with a footprint focused to a specific region.

- **Technology Fragmentation:** Multi-domain Single Administrations
  - Having different networks and different parts of a network built as different domains using **separate technologies**, such as optical or packet switched (with different packet switching paradigms included).
  - There are other reasons for having multiple domains within an operator, such as, **different geographies, different performance characteristics, scalability, policy** or simply historic (e.g., result of a merge or an acquisition)

Multi-domain Network Virtualization: https://tools.ietf.org/html/draft-bernardos-nfvrg-multidomain-04
Network Service Orchestration: A Survey https://arxiv.org/pdf/1803.06596.pdf

Multi-domain SFC

❖ The delivery of end-to-end services often requires **various Service Functions (SFs)**.

❖ Service Function Chaining (SFC) is constructed as an **abstract sequence of SFs.**

❖ Multi-domain SFC refers to the ability to **deploy SFC across multiple domains** (geo-location, technology, administration, etc.).

❖ To do so, an inter-domain communication process between different domains is necessary in order to:

  ■ Exchange **topology, resource and service** information,
  ■ And then **compute inter-domain service function paths**.

Service Function Chaining (SFC) Architecture https://tools.ietf.org/html/rfc7665
Hierarchical Service Function Chaining (hSFC) https://tools.ietf.org/html/draft-ietf-sfc-hierarchical-11
Hybrid Hierarchical Multi-Domain Service Function chaining https://tools.ietf.org/html/draft-li-sfc-hhsfc-04

Multi-domain SFC - Related Work (1/2)

❖ **IETF - SFC WG**

➢ [hSFC] defines an architecture to deploy SFC in large networks. This draft proposes to **decompose the network into smaller domains** (domains under the control of a single organization).

➢ [DRAFT-HH-MDSFC] describes **SFC crossing different domains** owned by different organizations (e.g., ISPs) or by a single organization with administration partitions. It proposes the use of a **SFC eXchange Platform (SXP)** to collect and exchange information (topology, service states, policies, etc.) between different organizations.

❖ **IRTF - NFVRG**

➢ The draft [DRAFT-MD-VIRT] envisions a complete **end-to-end logical network as stitching services offered by multiple domains from multiple providers**. It also points to the need for creating solutions that enable the exchange of relevant information (resources and topologies) across different providers.

❖ **ETSI - NFV ISG**

➢ The document [ETSI-NFV-IFA028] reports different NFV MANO architectural approaches with use cases related to **network services provided using multiple administrative domains**.

Multi-domain SFC - Related Work (2/2)

❖ Several projects include an **architectural model integrating NFV management with SDN control capabilities** to address the challenges towards **flexible, dynamic, and on-demand service chaining**.

  ➢ [VITAL][T-NOVA] follow a centralized approach where each domain advertises its capabilities to a federation layer which will act as a broker.

  ➢ [5GEx] aims to integrate multiple administrations and technologies through the collaboration between operators in the context of emerging 5G networking.

  ➢ The 5G-Transformer project [5G-TRANSFORMER] is defining flexible slicing and federation of transport networking and computing resources across multiple domains.

ALTO for Multi-domain SFC

❖ The ALTO protocol **[RFC7285]** **provides abstract network information** in the form of **map services** that can be consumed by applications in order to become **network-aware** and to take **optimized decisions** regarding traffic flows.

❖ WHY ALTO?

➢ The WG is discussing the use of ALTO as an information model for representing network, resource, and services in multi-domain scenarios.

  ■ The Broker-assisted architecture for multi-domain orchestration in 5G networks **[draft-alto-brokermdo-01]**

  ■ The Unicorn architecture for multi-domain, collaborative data sciences **[draft-alto-multidomain-analytics-01]**

❖ Some advantages:

➢ Use the ALTO **Property Map service to get a clear global view** (resource and service information) of other potential candidates domains.

➢ Use the ALTO **Cost Map service (and extensions) to compute inter-domain service function paths**.

Motivating Use Case (1/3)

❖ To enable a highly customized multi-domains SFC, **[DRAFT-HH-MDSFC]** proposes a **SFC eXchange Platform to realize inter-domain communication** between top-level control planes.
  ➢ The SXP is a **logical entity deployed in future Software-defined IXP** (as a trusted third-party platform) or built by a single owner between different networks.

❖ On a high level, the scope of the SXP contains two main tasks:
  ➢ Provide **end-to-end visibility through the collection of topology information, service states, and policies** from different domains.
  ➢ **Compute inter-domain service function path** to select the service function location from multiple candidate domains.

❖ In this context, the SXP can take advantage of **multi-domain ALTO services to obtain important inter-domain information** to "guide" the resource/service provider selection process.
  ➢ So that the "best" domain or candidate domains (according to policies/metrics) can be selected.

Motivating Use Case (2/3)
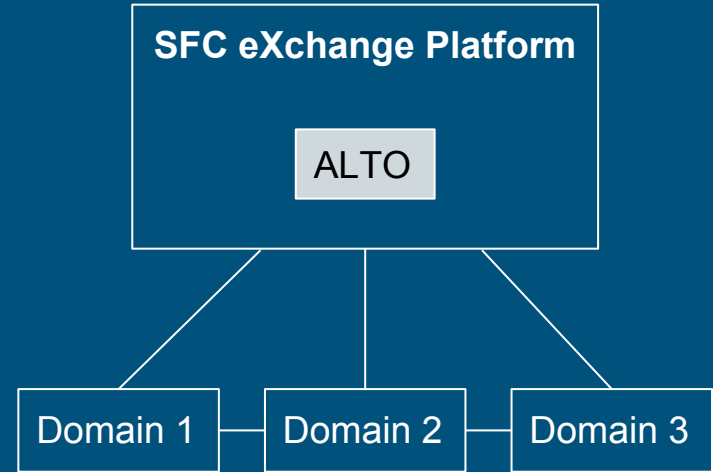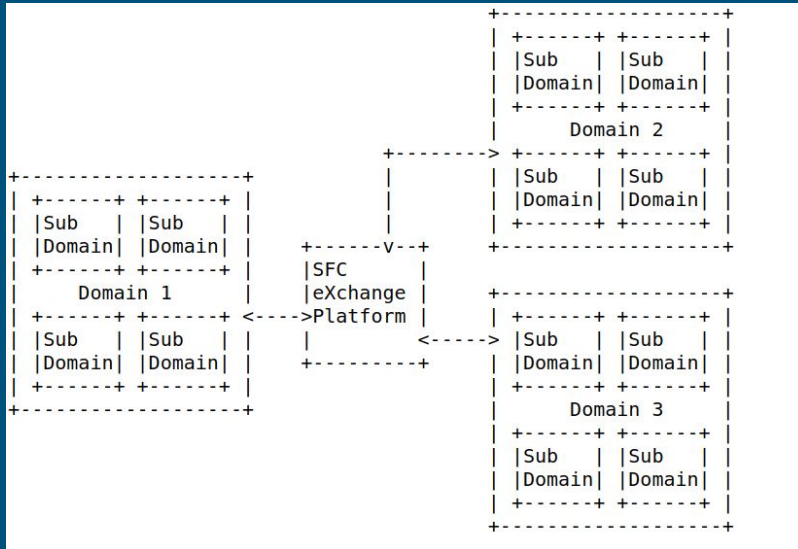
Multiple SFC domains connected by a SFC eXchange Platform

Motivating Use Case (3/3)

SFC eXchange Platform

ALTO

Domain 1   Domain 2   Domain 3

AS1   AS2   AS3

SF1   SF2   SF3
       SF3

SF=Service Function
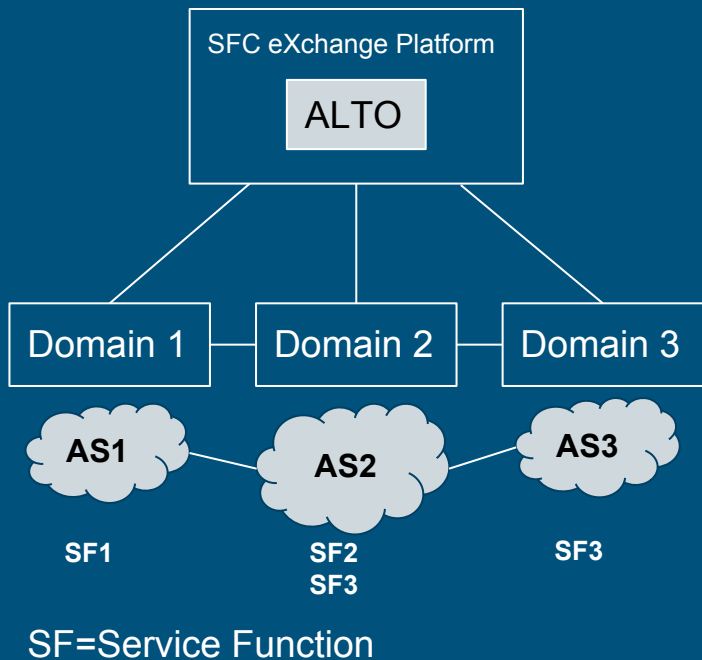
AS-level topology:

AS1<->AS2<->AS3

Property Map

```
+------+------+------------+------+
|      |      |    SFs     | ...  |
|      |      |            |      |
+------+------+------------+------+
| AS1  |      |   {SF1}    | ...  |
| AS2  |      | {SF2, SF3} | ...  |
| AS3  |      |   {NF3}    | ...  |
+------+------+------------+------+
```

Cost Map

```
+-----------------+-----------------------------------------+
|      SFC        |   Multi-domain Service Function Paths(SFPs) |
|                 |                                         |
+-----------------+-----------------------------------------+
| SF1->SF2->SF3   | 1:{AS1:SF1->AS2:SF2->AS2:SF3}           |
|                 |                                         |
|                 | 2:{AS1:SF1->AS2:SF2->AS3:SF3}           |
|                 |                                         |
+-----------------+-----------------------------------------+
```

Open Questions

- ❖ The SFC WG is currently scoped to **one single administrative domain**.
  - ➢ In the hierarchical SFC draft **[hSFC]**, the assumption is that sub-domains are **managed by the same administrative** entity.
- ❖ Before going into protocol details regarding how to realize inter-domain service chains:
  - ➢ Describe **concrete uses cases** which require **SFs from distinct administrative domains**. Related projects include **large, collaborative science experiments** (e.g., Large Hadron Collider).
  - ➢ Justify why **topology visibility** is required
- ❖ Security/Privacy Considerations
  - ➢ Using ALTO **extensions** (e.g., Multi-Cost, Cost-Calendar, Unified Property, Path Vector) to **provide fine-grained network information** may raise new security / privacy concerns. A systematic study is required.

Next Steps

❖ Gather **feedback** from the WG
  ➢ Comments, questions, suggestions are greatly appreciated, especially on open questions.
  ➢ -00 version reviewed by Mohamed Boucadair:
    ■ Comments addressed in -01

Thanks!