NFVI PoP network topology: Problem statement

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The NFVI PoP is essentially as data center

- Nodes will be interconnected forming the NFVI PoP interconnection network.

- **The goal is to explore desireable properties for the interconnection network, and determine which are the key factors to be considered.**

Outline

- **Design Considerations: What we consider**
  - The relevant factors to consider
  - Our considerations

- Goals: What we aim

The external line distribution is a key factor of the design.

- A local PoP has several thousands of lines with small capacity to the access network and tens of links to core network with greater capacity

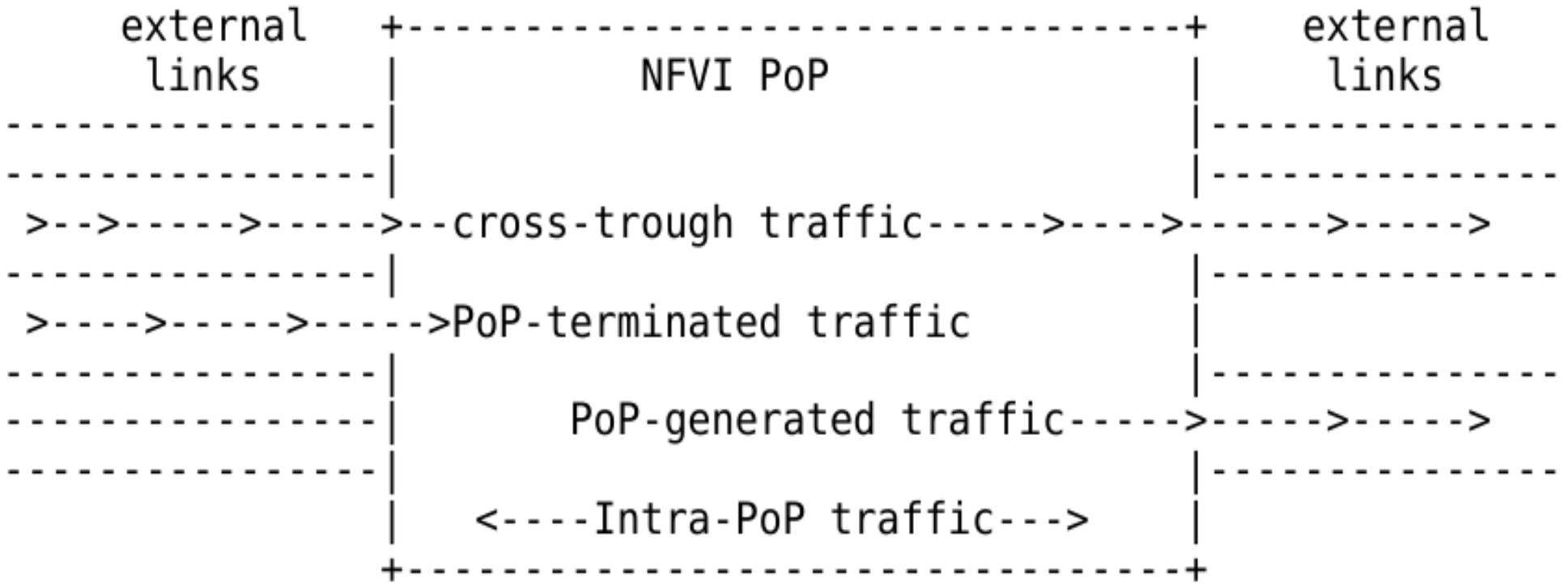
- A regional PoP only has a limited amount of links with great capacity.

The size matters!

- For tens of servers DC's are likely to use simple tree like topologies.
- For bigger DC's more sophisticated topologies are required (Fat-tree, jellyfish, etc).
- Depends from several factors:
  - External links
  - The services offered concurrently
  - The number of VNFs
  - Service performance implications

We consider 4 types of macroscopic traffic directions for the design

- Served by the PoP
  - **Cross-trough traffic** (Processed Traffic)
  - **PoP-generated traffic** (Cache servers)
  - **PoP-terminated traffic** (Firewalls)
- Operation and management
  - **Intra-PoP traffic** (VM movement, signaling, etc)
- **The distribution of the traffic among these categories is a key factor**


external links
NFVI PoP
external links
cross-trough traffic
PoP-terminated traffic
PoP-generated traffic
<----Intra-PoP traffic--->

The traffic locality factors impact on the design

- The topological locality of the VNFs composing a SFC.

- The locality and relationship between the external lines.

The service deployment strategy has to be considered.

- Parallel SFC deployment
- Sequential SFC
- Hybrid strategy

- Factors involved: performance, licensing, law requirements.

Other service parameters also affect the topology design.

- The number of servers that the traffic served by the PoP will traverse.
- The number of different SFCs that will be simultaneously available in the PoP at any point in time.
- How often the provided SFCs will change

There are several service conforming technologies

- IETF SFC and SDN are two difrerent alternatives to do the Service Function Chaining.

- **Different technologies result in different topology constraints.**

The service life cycle must also be considered

- How often the provided SFCs will change
- The lifetime of the VNFs and virtual machines
- **This affects the amount of churn traffic in the PoP.**

The size...and the growth in terms of offered load and VNFs

- Different PoP require different server grow paces (lineal, exponential, etc).
- The expected growth in the effective load is most relevant to design the topology.
- How the number of VNFs and the length of the services grow also affects the topology design.

NFV gives the possibility of deploying networks with new paradigms

- Current topologies are mostly Indirect Networks, which distinguish between traffic nodes.

- **NFV introduces the possibility of using Direct Networks, where every node can forward, sink or generate traffic.**

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The main goal is to forward traffic between the different external links

- The performance of the PoP will be directly determined by this effective load.
- Affected by the traffic patterns, the routing and the locality considerations.
- **Related indicators: bisection bandwidth, packet loss.**

The overall service latency is a key objective

- This involves traverse all the VNF's of the service and reach the external line.

- Only take in count the number of hops the packet should traverse.
- Mean and maximum are important.

Scale is one of the reasons for introducing NFV.

- In terms of: servers, link speeds and external links capacity
- To scale some topologies require growing some components beyond what is technically feasible.
- Different topologies have different growing models.

The topology must be performant...and fault tolerant

- Node-disjoint paths
- Edge disjoint paths
- f-fault tolerance
- Redundancy level

Cost and Backward compatibility

- The overall cost of the switches, and the cost per interface of the topology.

- NFV is going to be incrementally introduced and hence the topology must be able to connect to previous technologies.

What Now?

- Simulations
- Analytical models

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An NFV PoP is essentially the place where NFV is deployed.
Of course the very first NFV PoP are going to be the NSP PoP.

This means NSP PoPs as we know the today, where all the traffic is steered through hardware appliances, will cease to exist in the next few years. Instead we will have Dcs composed by regular servers and services deployed as chains of VNFs
An NFVI PoP is defined as a "single geographic location where a number of NFVI-Nodes are sited" where an NFVI-Node is "a physical device deployed and managed as a single entity providing the NFVI functions required to support the execution environment for VNFs" [ETSI_GS_NFV-INF_001].

Outline

- **Design Considerations: What we consider**
  - The relevant factors to consider
  - Our considerations
- Goals: What we aim

Im going to divide this presentation in two sections:
In the first one, which Im going to start after this slide, Im going to talk about the factors that affect design decisions of the network topologies

And in the second one I will describe the goals we have, and the indicators related to them so we can compare the topologies.

In both sections Ill be taking top down approach. So now I want you to start thinking about the general concept of a PoP, forgetting about the newtork functions, and the servers inside.

The external line distribution is a key factor of the design.

- A local PoP has several thousands of lines with small capacity to the access network and tens of links to core network with greater capacity
- A regional PoP only has a limited amount of links with great capacity.

And the very first concern that should come to your mind is how the data is going to arrive to that PoP. This involves the amount of lines, its capacity, etc. And is the main key factor, because is going to determin the amount of traffic we need to process.

Just to give you two examples you can think of..

The size matters!

- For tens of servers DC's are likely to use simple tree like topologies.
- For bigger DC's more sophisticated topologies are required (Fat-tree, jellyfish, etc).
- Depends from several factors:
  - External links
  - The services offered concurrently
  - The number of VNFs
  - Service performance implications

We dont need to know the exact number of servers, but the order of magnitude is most important when designing a topology. Some topologies are technically unfeasible to scale more thana certain number of servers, or they are very expensive.

Of course the main factor driving the size of the DC is the amount of traffic that I said earlier, but there are other factors that also affect. The amount of services offered at the same time for instance impacts on the computing capacity required and therefore affects the size of the DC. The number of different VNFs

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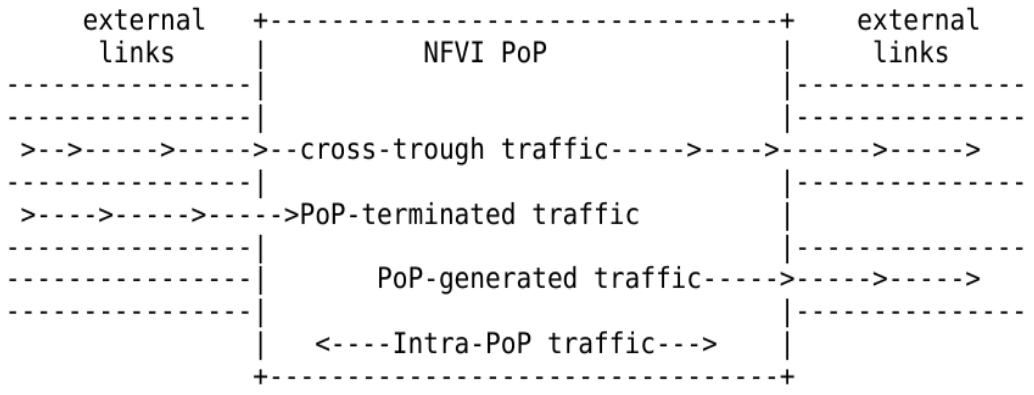
The cross-trough traffic is the traffic that reaches the PoP through an external link, it is processed by a service function chain is one of the main purposes of the PoP since the PoP is part of the operator's infrastructure whose main purpose is to forward user's traffic.

The PoP-generated traffic is generated by VNFs located within the PoP. An example of such VNF would be a cache located inside the PoP which serves content to users. Similarly, PoP-terminated traffic is external traffic that is terminated by one VNF located inside the PoP for example a firewall.

Intra-PoP traffic is traffic generated and terminated inside the PoP that never leaves the PoP. This traffic includes much of the management traffic, deploying and moving virtual machines and VNFs across different servers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Consider the case of a Local PoP, which has links connecting to users (DSL, FTTH, etc) and links connecting to the rest of the provider's network. Let's call the first type of links user's links and the second type of links, core links. It is reasonable to assume that most of the traffic coming from a user's link will go to a core link and vice-versa. We can expect that thetraffic between two user's links will be low and the same for the traffic between two core links. If we now consider the case of a regional PoP, it is not so clear we can make such assumption about the traffic between links.

The service deployment strategy has to be considered.

- Parallel SFC deployment
- Sequential SFC
- Hybrid strategy

- Factors involved: performance, licensing, law requirements.

One possible approach is to deploy all the VNFs of a given service function chain in a single server and deploy as many of these servers in parallel in order to server the different flows.

Another possible approach would be to deploy each VNF in a different server and have one (or more) servers dedicated to process this particular VNF for all the flows of the PoP.

Hybrid strategy: it is also possible to use a hybrid strategy, where several VNFs of the SFC are deployed together in a server and other VNFs of the SFC are deployed in separated servers.

Other service parameters also affect the topology design.

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- Affected by the traffic patterns, the routing and the locality considerations.
- **Related indicators: bisection bandwidth, packet loss.**

Moreover, in order for the comparison of two topologies to make sense, they need to be "equal" in some other dimension (e.g. cost, number of servers, number of links, number of switches or else).

Affected by multiple factors, including the the different aspects we described in the traffic patterns

as a starting point, DESCRIBE PROJECT

The overall service latency is a key objective

- This involves traverse all the VNF's of the service and reach the external line.

- Only take in count the number of hops the packet should traverse.
- Mean and maximum are important.

e latency/Hop count depends on the
traffic matrix (i.e. the relation of the input and output links), the
routing and the different locality aspects, hence it is useful to
have information about these aspects.

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