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-SDN-AGNOSTIC NFV ARCHITECTURE

Before the appearance of NFV, NFs were built as a closed combination of software and hard- ware from vendors. NFV is a step forward for the provisioning of network functions and enables the decoupling of software from hard- ware. This decomposition relies on the virtualization layer, which exposes virtual resources (i.e., computing, storage, and network) that become the building blocks for NFs. Moreover, the deployment of NFs becomes more flexible as they are based on software and not attached to specific hardware. As the NF turns into instantiable software (VNF), it provides more flexibility to scale up/down with finer granularity according to the actual traffic and NF performance.

The NFV architecture promoted by ETSI leverages on compute, storage, and network virtual resources, and NFs are virtualized and encapsulated as a software package, like a virtual machine (VM), that relies on these components. The underlying network infrastructure, included in the NFV infrastructure (NFVI), is abstracted to realize virtualized network paths that provide connectivity to support the inter- connection between VNFs and with the end- points. Therefore, the VNFs are software boxes running on commodity servers to process the frames coming from the underlying network, and consequently, compute resources are the main architectural component to build the NFs. In this regard, virtual network resources are limited to providing an interface to the underlying network resources, which are mostly considered just for providing connectivity service.

-SDN-AWARE NFV ARCHITECTURE

Since the initial proposal of the NFV concept, its relationship with SDN was argued to be complementary and potentially of added value when both technologies are combined. The separation of data forwarding from the control plane improves the flexibility of the network and simplifies the dynamic deployment and operation of resources. In addition, the usage of commodity servers and switches, avoiding specific hardware based components provided by vendors, is a shared objective between NFV and SDN. More- over, some of the networking challenges of the NFV architecture to be addressed match the design goals of SDN, such as dynamic control and configuration of network nodes and auto- mated management of the network. Others, like elastic and fine-grained scalability adapted to the actual needs, seamless mobility of resources, and efficient multi-tenancy support, can be built on SDN capabilities.

Thus, even if the first ETSI architecture did not explicitly mention SDN as part of the NFVI, the ONF quickly published the envisioned scenario of cooperation between SDN and NFV, which contributed to simplify the integration of both physical and virtual networking infrastructures by using a common interface. As part of this contribution, the ONF depicts a possible interaction between the NFV Orchestration component and the OpenFlow Controller, which is based on a northbound interface exposed by the latter.

Further pursuing this approach, the latest documents from ETSI integrate SDN with the defined architecture and reference points for NFVI. However, the contributions of SDN remain in the infrastructure network domain of the NFVI, focused on providing connectivity services; and despite being a perfect complement for NFV, it does not tackle the compute-based design of VNFs. Since the main difference from the previous approach lies only in the network infrastructure, the same examples apply here. The main idea is that the compute resources (e.g., the CG-NAT) must process all the data traffic. The network infrastructure still only provides connectivity services, albeit more dynamic and programmable.