Verification of NFV Services : Problem Statement and Challenges

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Update since IETF91

- New Title
  - **Verification of NFV Services : Problem Statement and Challenges**

- A co-author added
  - **Tae-wan Kim from operators**

- Verification framework is newly revised and discussed based on the latest NFV phase-2 works (e.g., terms, framework, etc.)

Motivation and Problems

○ Motivation

   ○ Check consistency and safety of network service configurations on virtual and physical resources

     ➢ Incomplete or inconsistent configuration of VNF and forwarding graph (FG, aka service chain) could cause break-down of the supporting infrastructure.

○ Network and service properties to be checked

1. Dependencies of Network Service Components
2. Loop-Free in VNF FGs
3. Policy and State Consistency
4. Load Balancing and Optimization among VNF Instances
5. Performance Bottleneck
6. Security Hole

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Properties (NFV vs. SDN)

| NFV context (Service-level)	SDN context (Network-level)
Dependency of network service components (e.g., network controller vs. VNF/resource manager/orchestrator)	No blackhole (e.g., no packet loss)
Loop-free in VNF FGs (aka. service chains)	Loop-free (e.g, routing/switching)
Load balancing and optimization in VNF FGs (aka. service chains)	Flow table rule consistency between multiple applications (E.g., OpenFlow)
Policy and state consistency (e.g., end-to-end context, virtual vs. physical resource, etc.)	Dynamic info/statistics consistency (e.g., flow, port, QoS, etc.)
Performance	Consistency with legacy L2/L3 protocols (e.g., STP)
Security (L4-L7)	Security (L3 firewall, etc.)

Minimal Requirements

○ R1 : It SHOULD be able to check global and local properties and invariants. (E.g., Loop-freeness and resource isolation between VNFs can be regarded as global. The policies that are related only to the specific network controllers or devices are local.)

○ R2 : It SHOULD be able to access to the entire resource DBs as well as network states whenever verification tasks are started.

○ R3 : It SHOULD be independent from specific solutions and frameworks, and APIs.

○ R4 : It SHOULD process standard protocols such as Netconf, YANG, OpenFlow, I2RS, etc. and northbound and southbound interfaces that are related network configurations, and used by OSS.

Verification Framework

○ Option 1 : Verification Manager in MANO

○ Option 2 : OSS interaction

○ Option 3 : VNF instances

Verification Framework

Option 1

MANO

Verification Manager

Orchestrator

OSS/BSS

Description

EMS 1 — EMS 2 / EMS 2 — EMS 3

VNF 1 — VNF 2 — VNF 3

VNF Manager(s)

NFVI

Virtual Computing — Virtual Storage — Virtual Network

Virtualisation Layer

Virtualised Infrastructure Manager(s)

Hardware resources

Computing Hardware — Storage Hardware — Network Hardware

APIs

Interpreter

Library / Library

Verifier

States DB
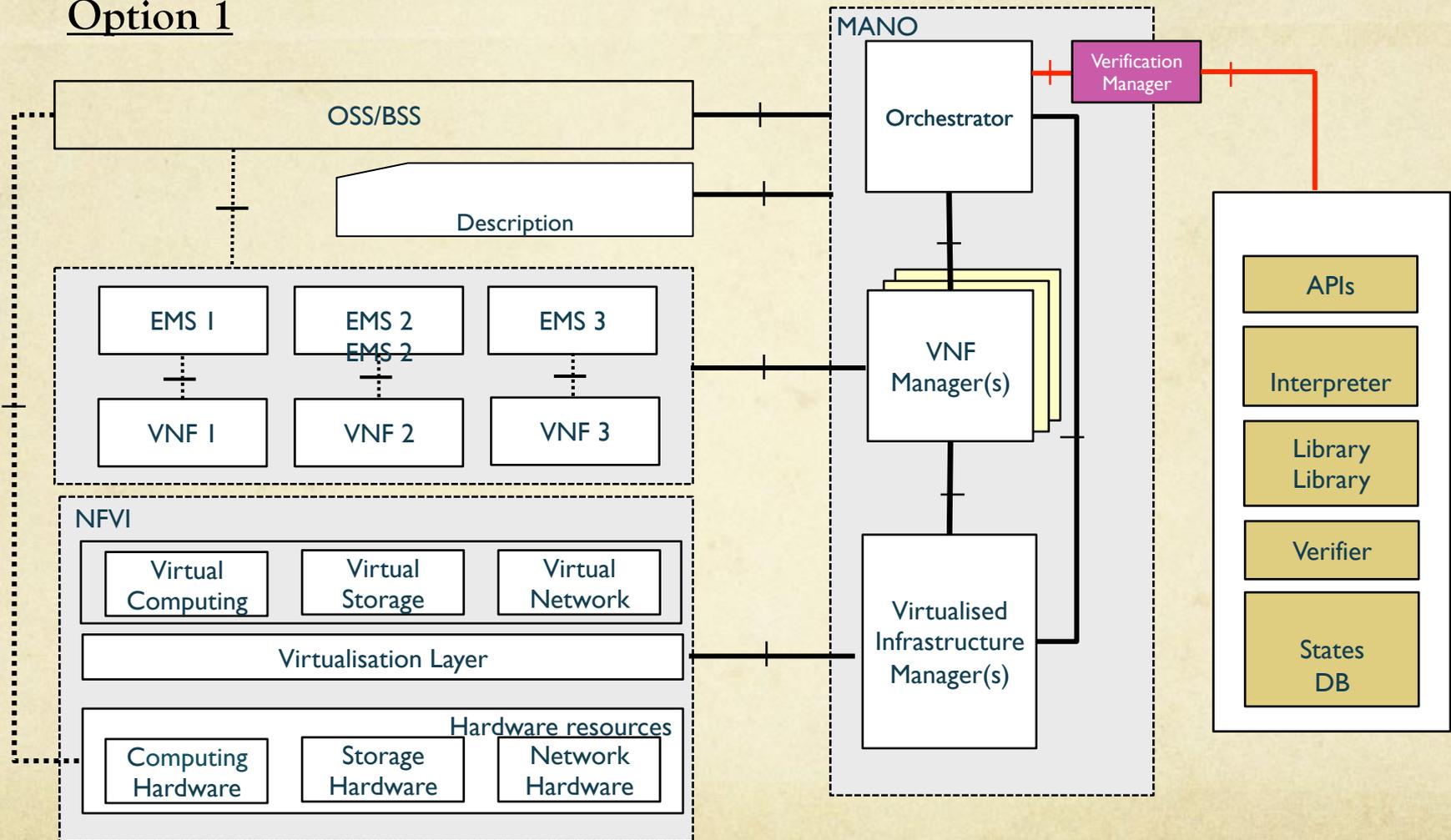
Note that Verification Service and Verification Manager in the NFV MANO should communicate using APIs to accomplish the verification tasks.

Option 3

OSS/BSS

Service, VNF and Infrastructure Description

Verification (EMS 1)
EMS 2
EMS 3

Verification (VNF)
VNF 2
VNF 3

NFVI

Virtual Computing
Virtual Storage
Virtual Network

Virtualisation Layer

Hardware resources
Computing Hardware
Storage Hardware
Network Hardware

MANO

Orchestrator

VNF Manager(s)

Virtualised Infrastructure Manager(s)
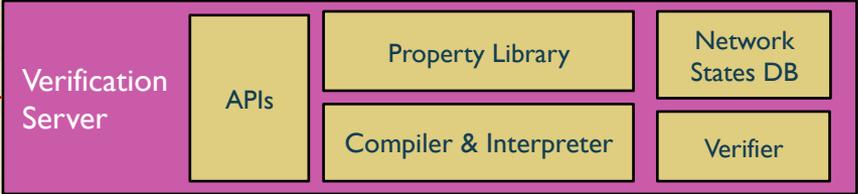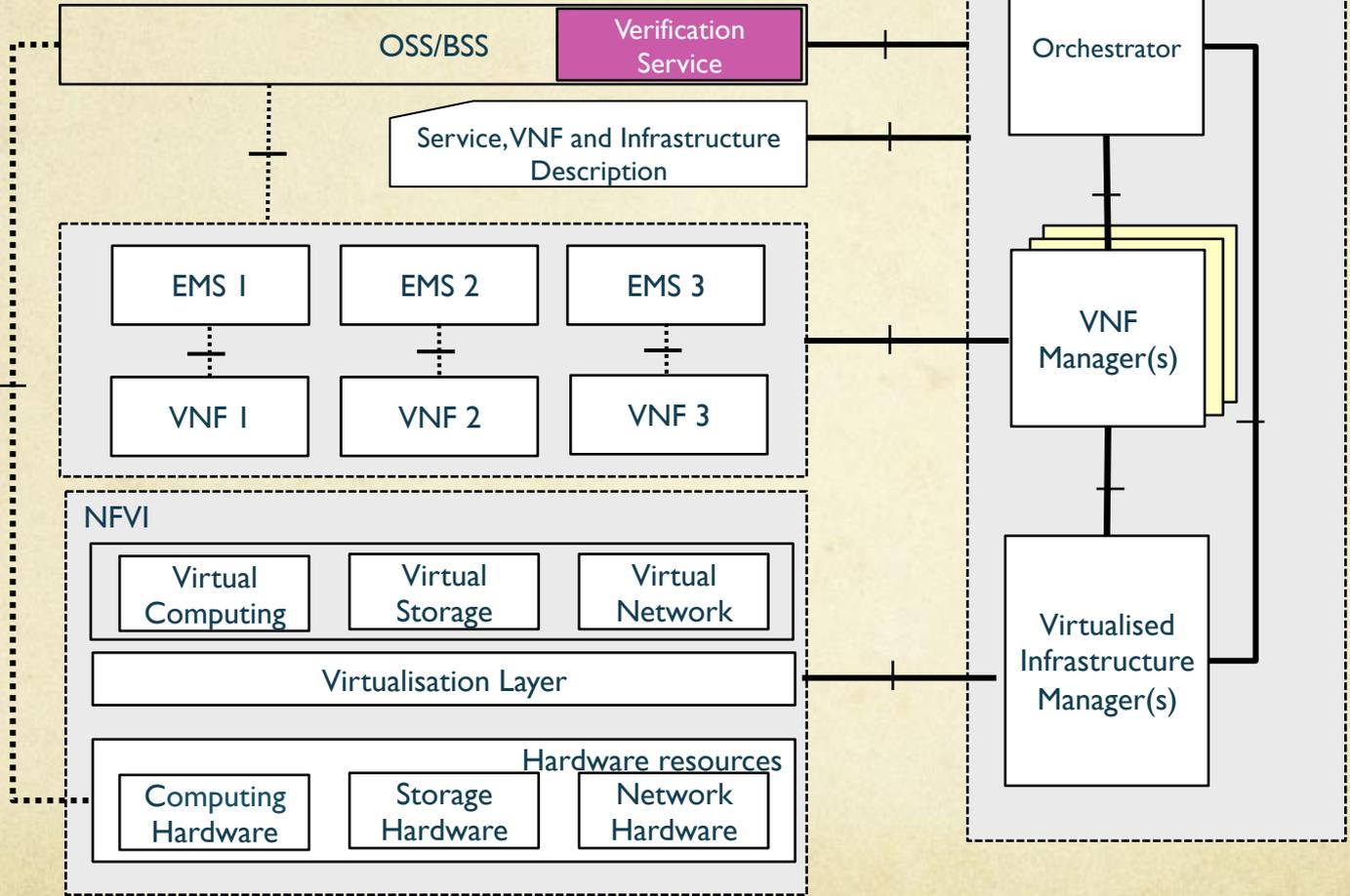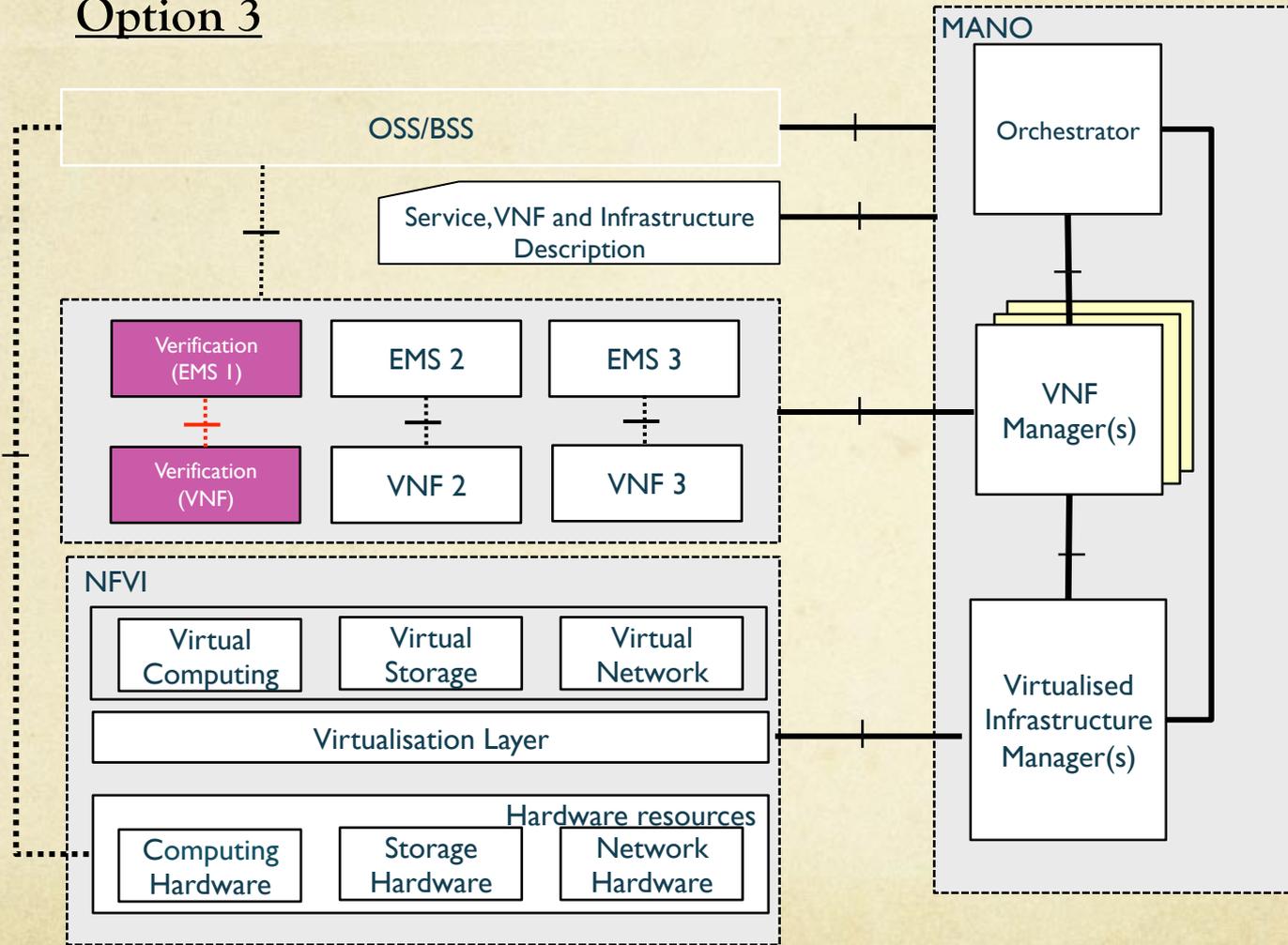
Challenging Issues

○ Finding infinite loops

　○ General solutions for the infinite loop can lead to intractable problem (e.g. the halting problem). To make the verification practical and minimize the complexity, some of the restrictions are required.

○ Real-time verification

　○ A few invariants can be checked in real-time but it would be impossible if the size of VNFs increases or properties checked are complex.

○ Languages and their semantics

　○ Network service descriptions in NFV need to be precisely expressed using appropriate semantics (e.g., formal method). Languages and semantic models optimized to the verification framework need to selected or newly developed.

Next Step

- Collect more requirements from operators and collaborate with ETSI NFV TST WG

- Investigate and be involved in open source projects (e.g., OPNFV as well as Open Daylight)

- Adopt as a RG document