Network Function Virtualization and Flexible Service Chaining in Multi-Domain/Provider Environments: Recent Developments

Keynote at NetSoft 2016

Robert Szabo, Ericsson Research

UNIFY is co-funded by the European Commission
DG CONNECT in FP7

Outline

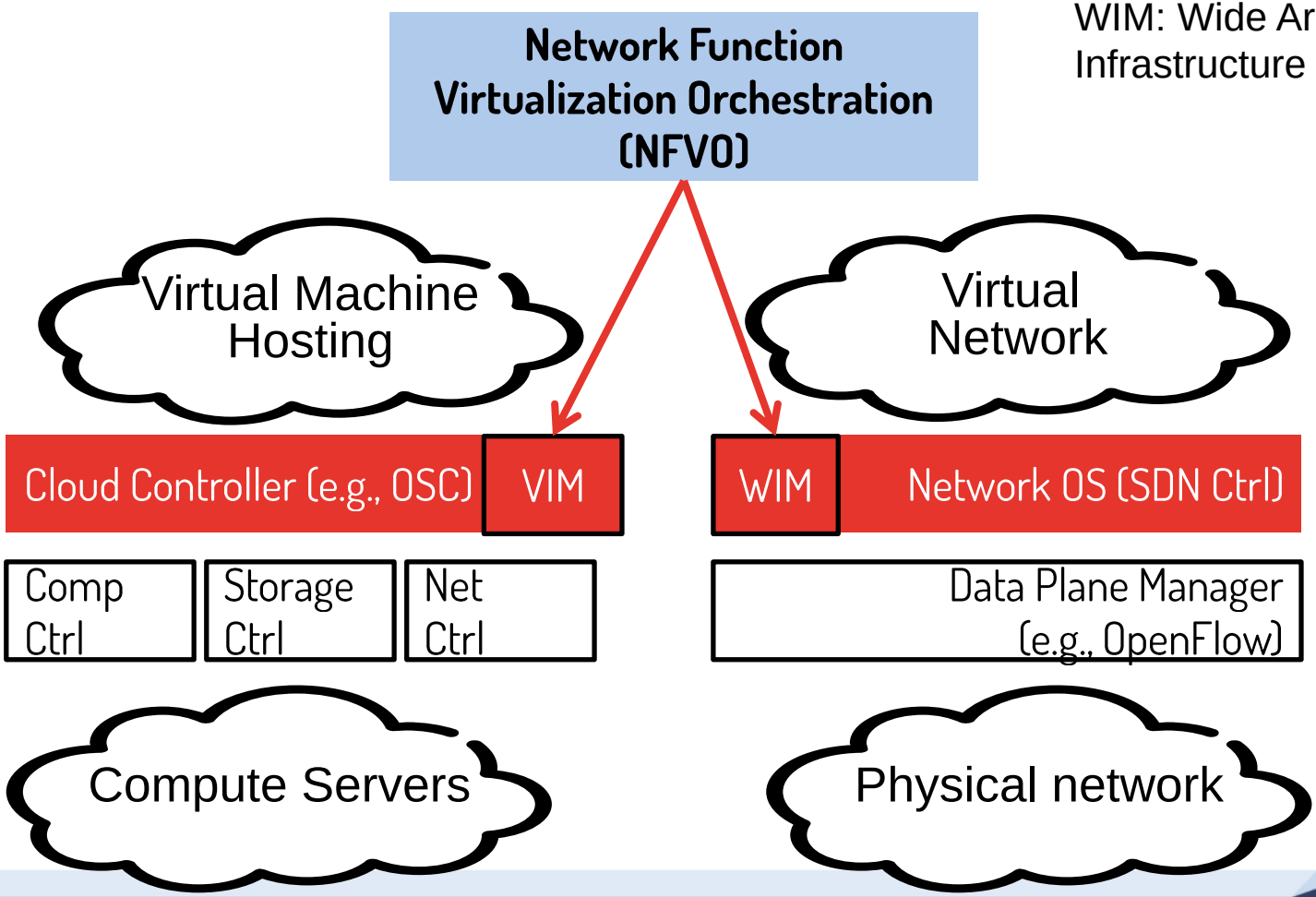
- ETSI NFV MANO Revived
- Technical and Business Implications
- Technical details
- Use-Case:
  Multi-Domain Multi-Technology Service Function Chaining
- Summary

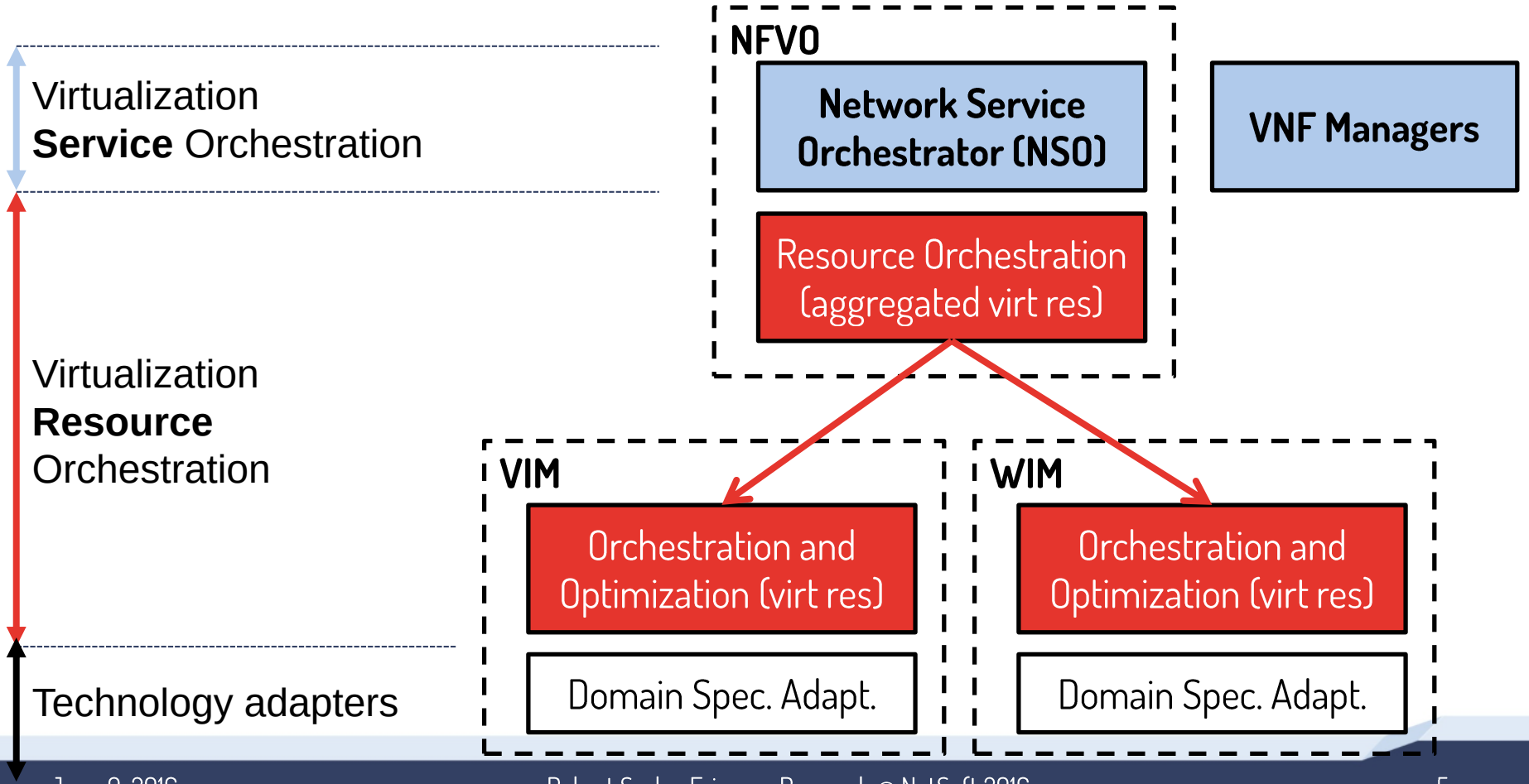
ETSI NFV MANO Revived

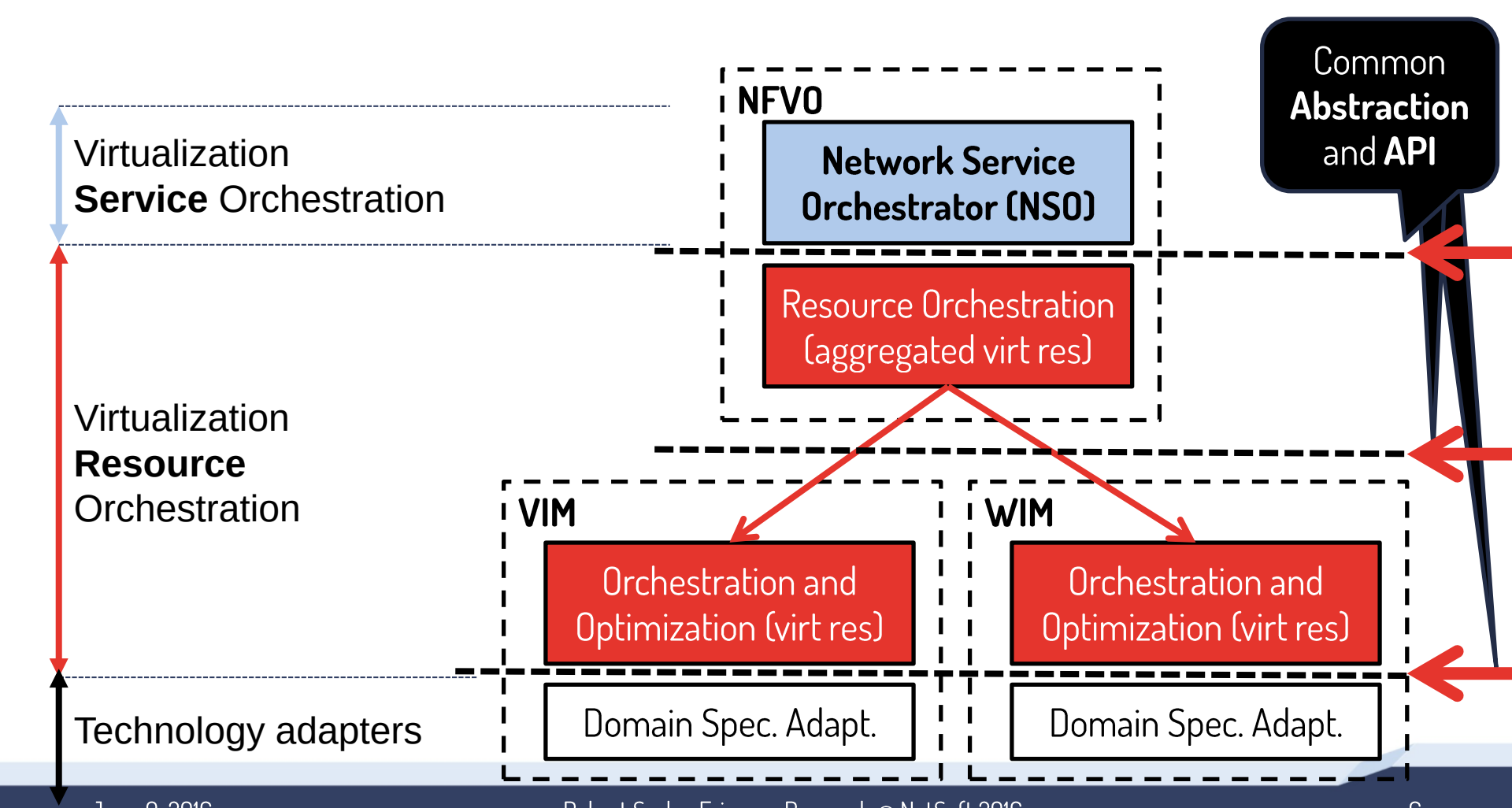
- ETSI NFV MANO Revived
- Implications
- Technical details
- UC-SFC
- Summary

UNIFY is co-funded by the European Commission
DG CONNECT in FP7

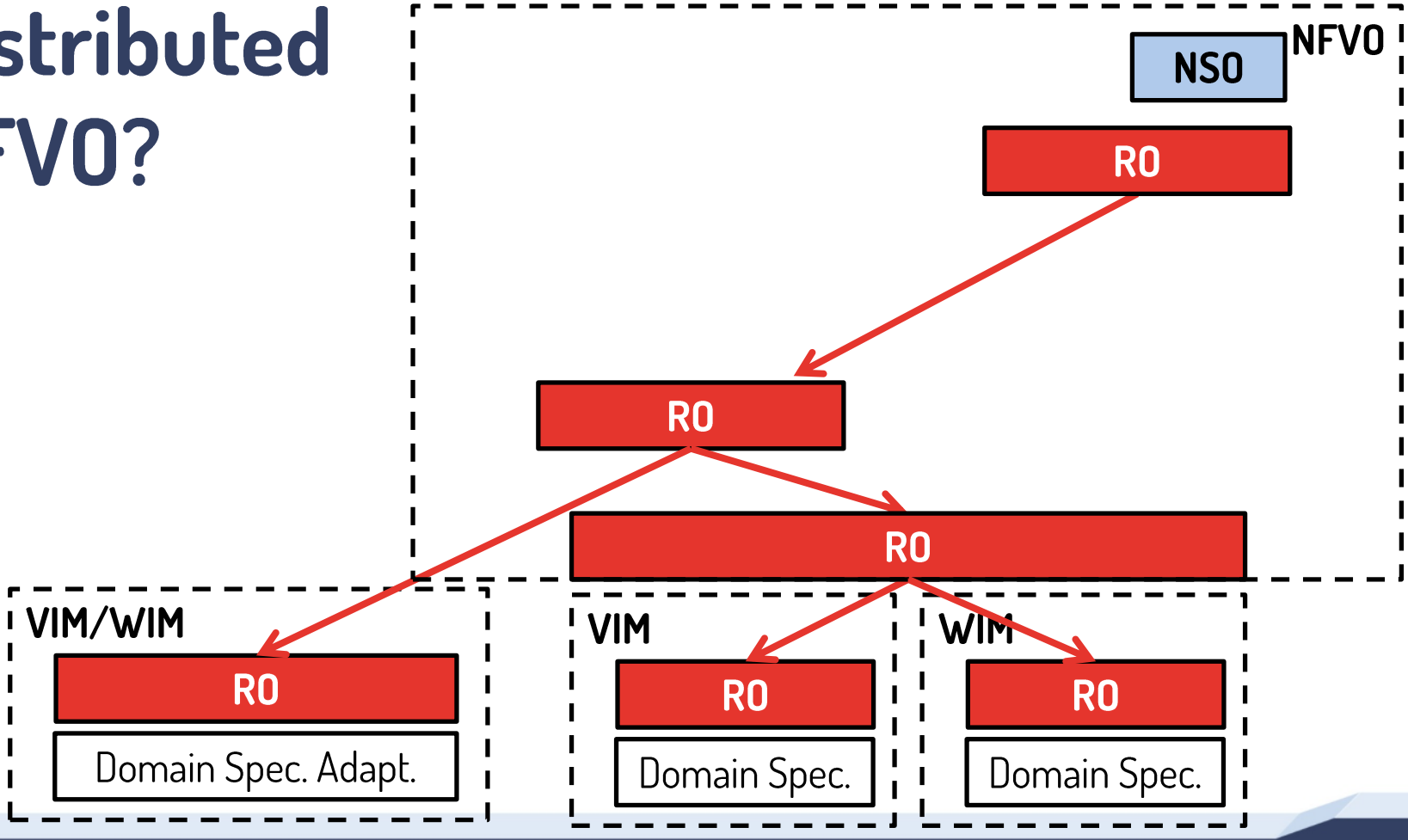
WIM: Wide Area Infrastructure Manager



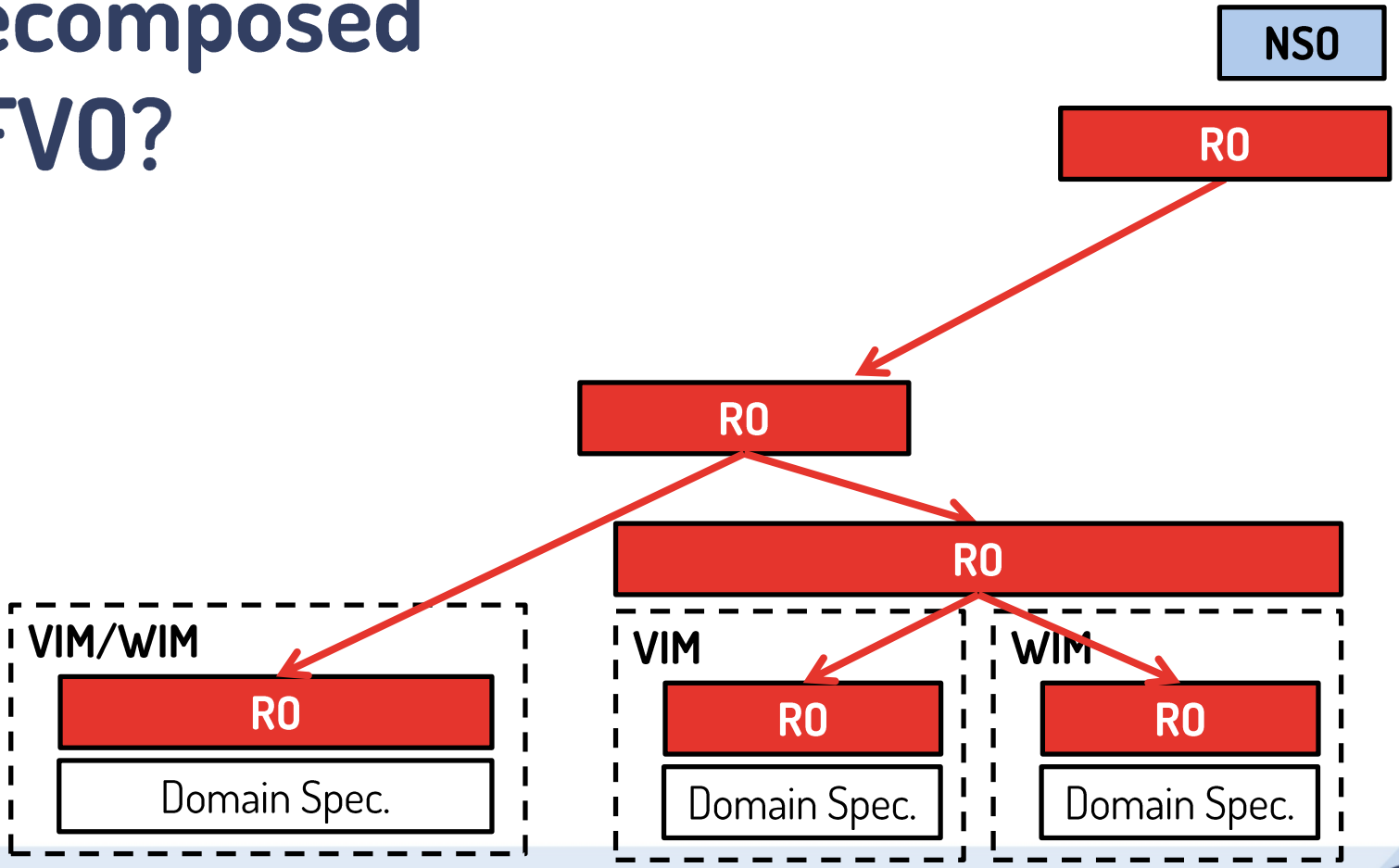

Virtualization
Service Orchestration
Virtualization
Resource
Orchestration
Technology adapters
NFVO
Network Service Orchestrator (NSO)
VNF Managers
Resource Orchestration (aggregated virt res)
VIM
Orchestration and Optimization (virt res)
Domain Spec. Adapt.
WIM
Orchestration and Optimization (virt res)
Domain Spec. Adapt.


Virtualization
Service Orchestration
Virtualization
Resource
Orchestration
Technology adapters
NFVO
Network Service Orchestrator (NSO)
Resource Orchestration (aggregated virt res)
VIM
Orchestration and Optimization (virt res)
Domain Spec. Adapt.
WIM
Orchestration and Optimization (virt res)
Domain Spec. Adapt.
Common **Abstraction** and **API**

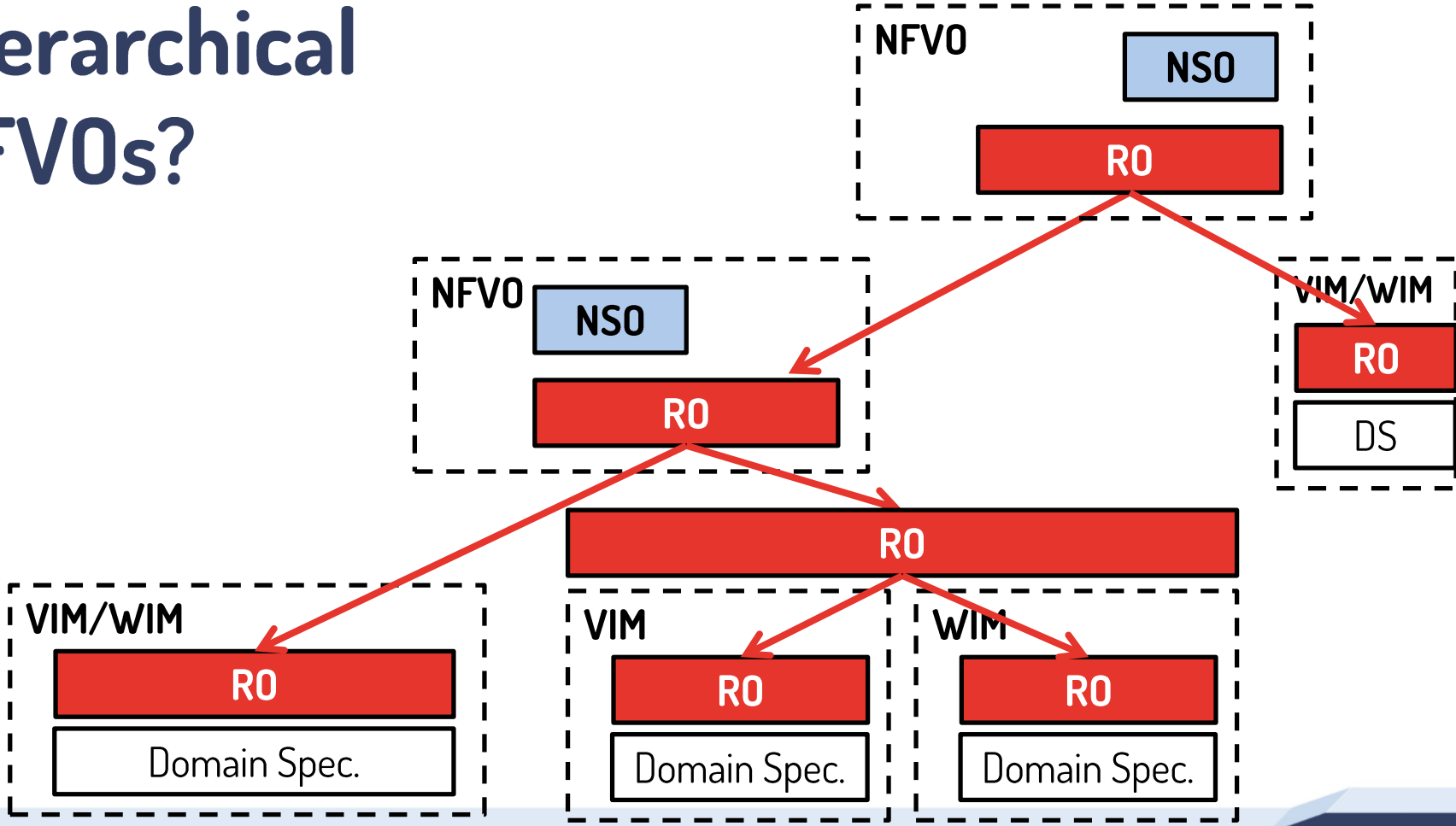
Distributed NFVO?



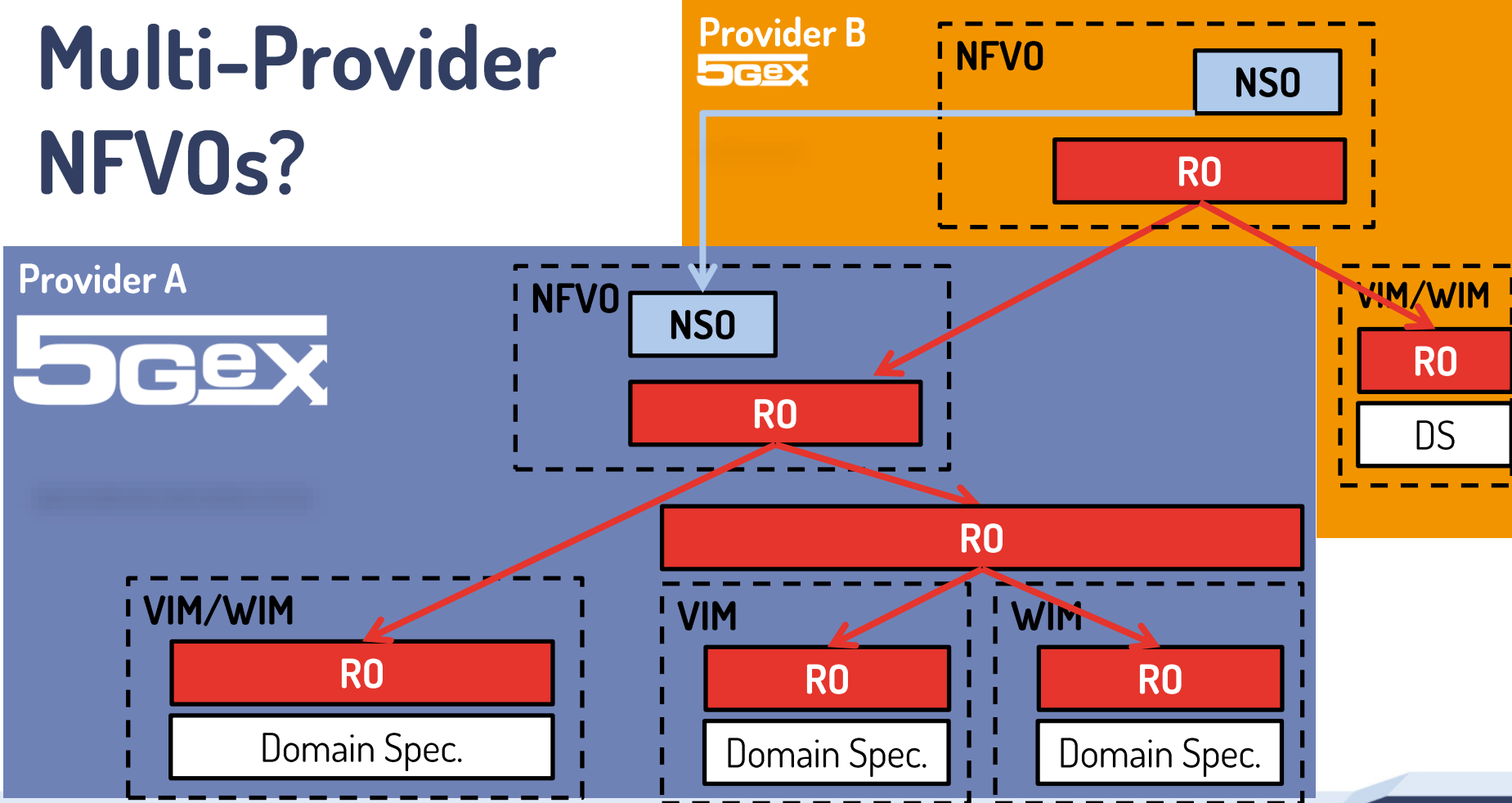
Decomposed NFVO?



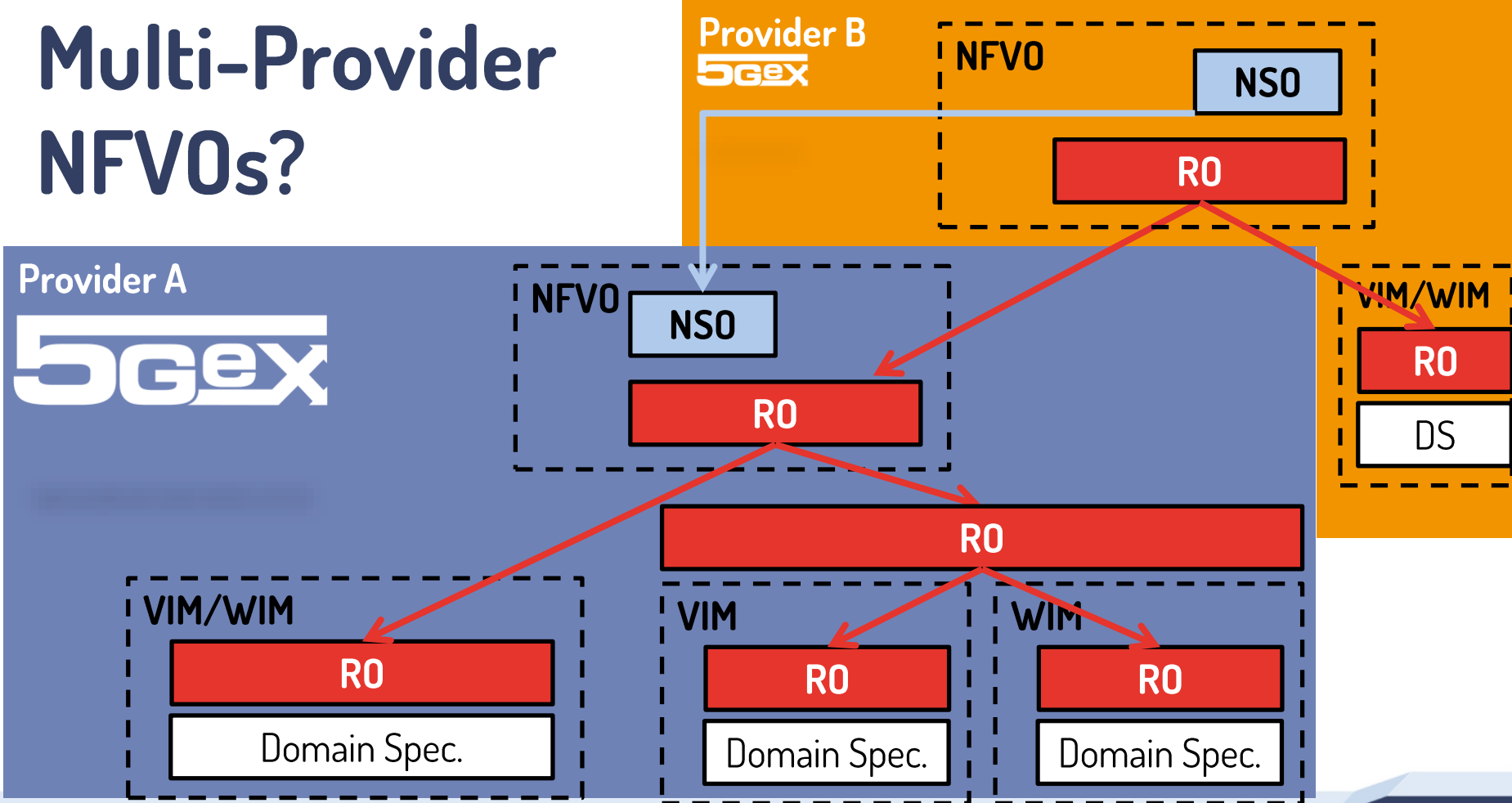
Hierarchical NFVOs?



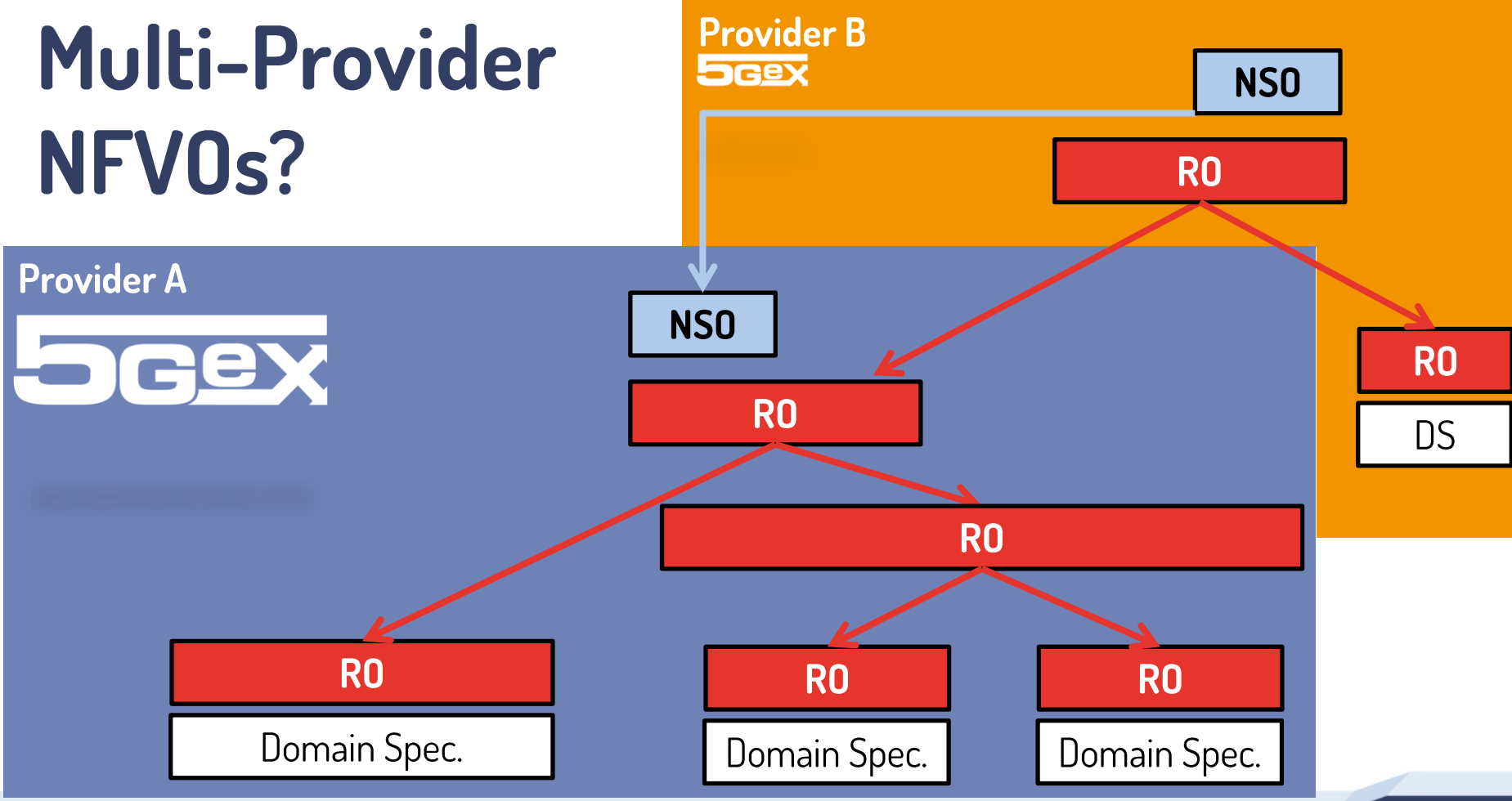
Multi-Provider NFVOs?



Multi-Provider NFVOs?

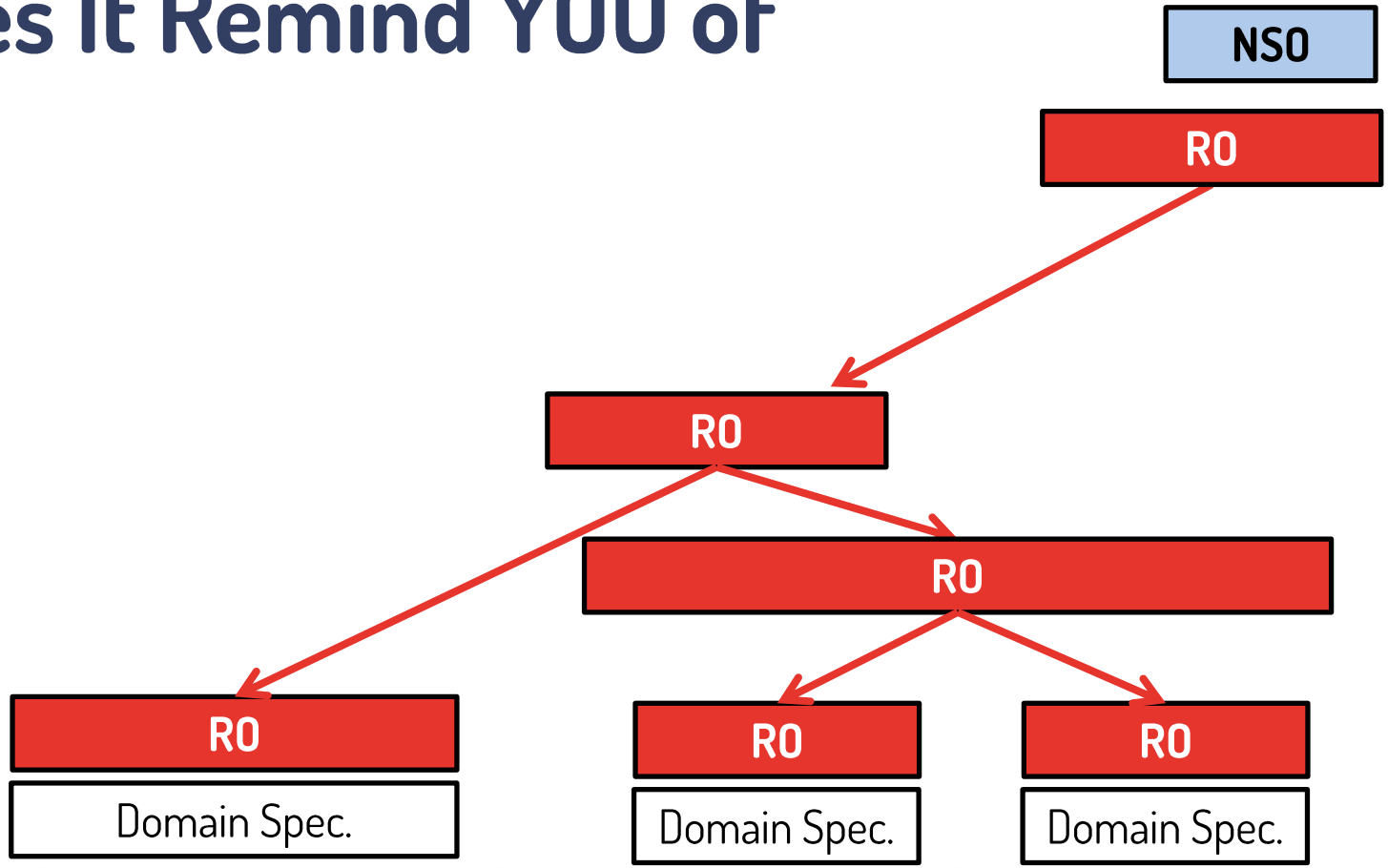


Multi-Provider NFVOs?

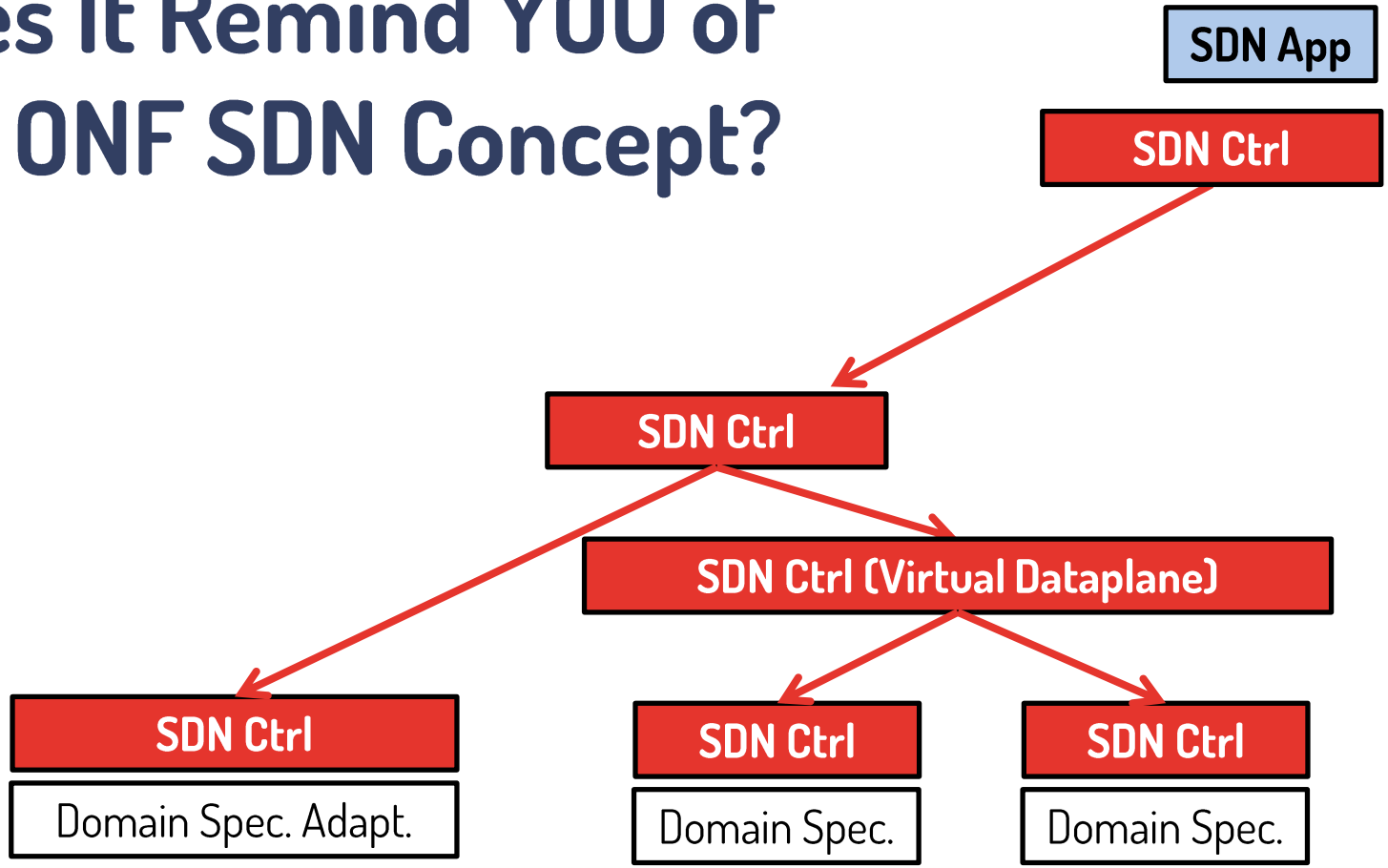


Does It Remind YOU of

...



Does It Remind YOU of the ONF SDN Concept?



Key Messages #1

A **different functional split** of the ETSI MANO architecture enables

- More clear separation of concerns
- Scalability by hierarchies (layers)
- New business interactions

Implications

- ETSI NFV MANO Revived
- Implications
- Technical details
- UC-SFC
- Summary

UNIFY is co-funded by the European Commission
DG CONNECT in FP7

Key Assumptions

- Edge Computing or highly distributed cloud
- Multi-**technology**, multi-**domains** and multi-**provider** environments (e2e)
- **Network** *can be* ***scarce*** **resource**
  - Somewhere in the e2e path

Technical Implications on

Resource Slice as a Service
SlaaS

ABSTRACTION

- <Topology of>
  - Resources
    and
  - Capabilities
    for both **software** and
    networking

CONTROL API

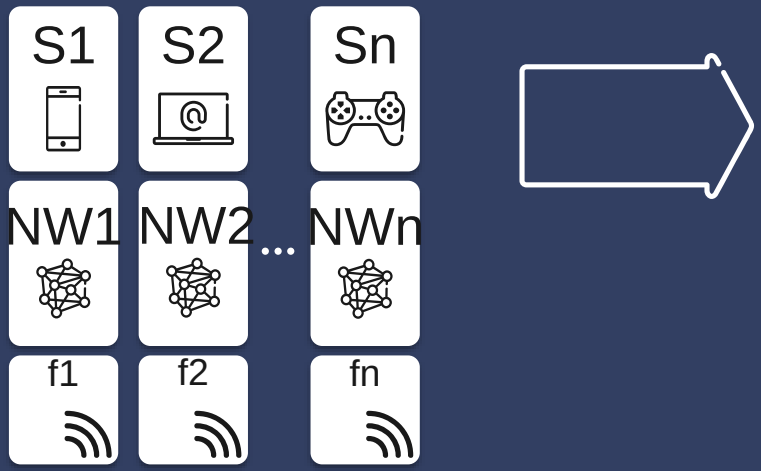
- <Embedment in the given topology>
- Requirements on
  - Latency, rate
  - CPU, mem, storage (flavor)
  - Locality, affinity, …

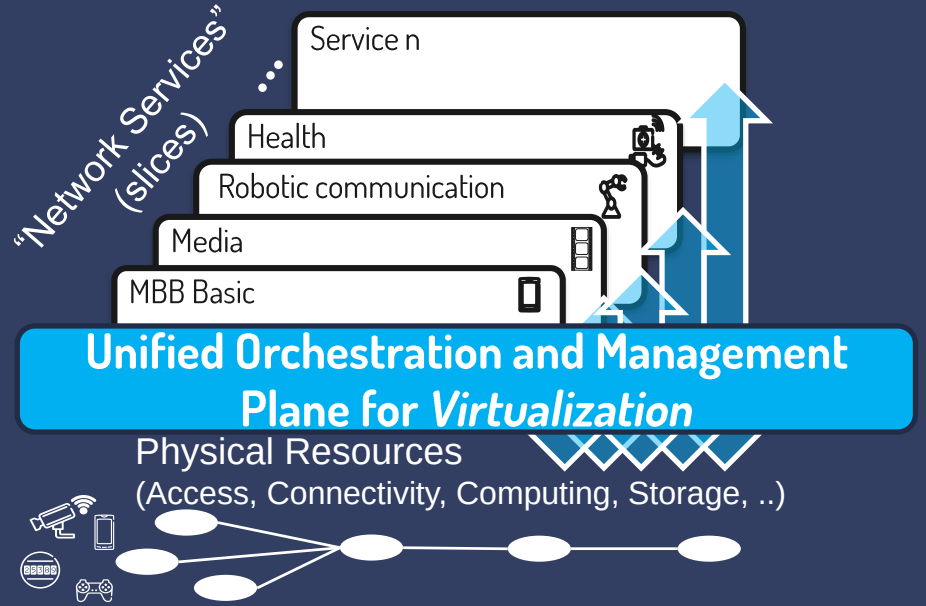
+ context for SLA, pricing, policies, etc…

Vision: One 5G Network – Multiple Industries

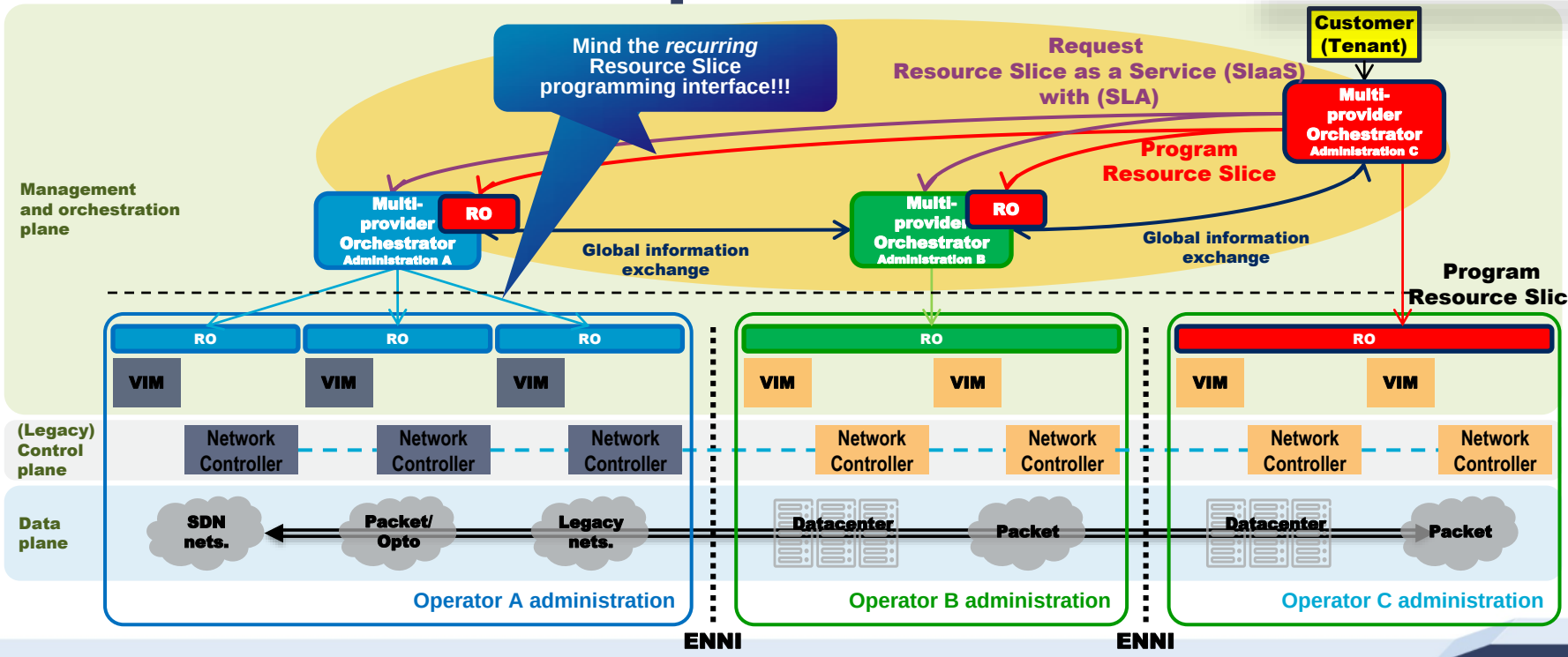
From dedicated physical networks and resources for different applications…

…to a "network factory" where **resources are traded and** new architectures are "manufactured by SW"

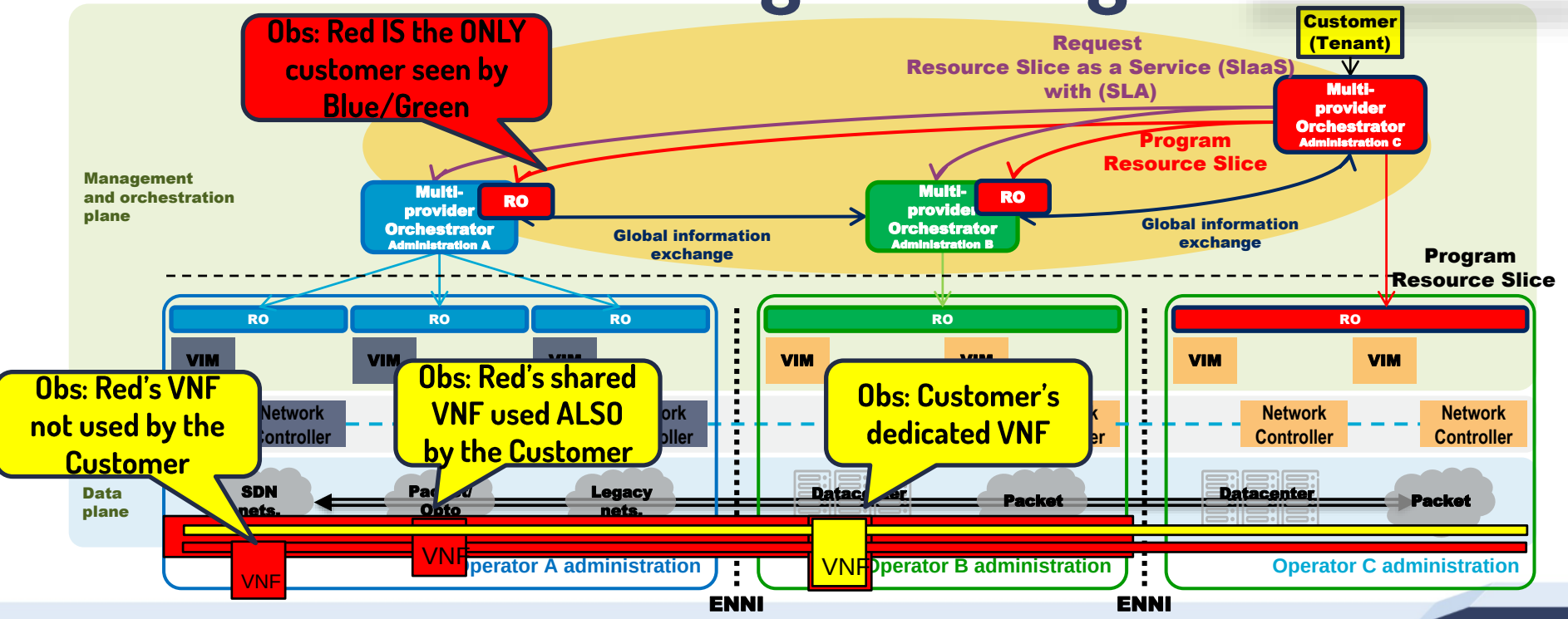




EU/5GPPP/ 5G Exchange – Multi-Provider Operation: SlaaS

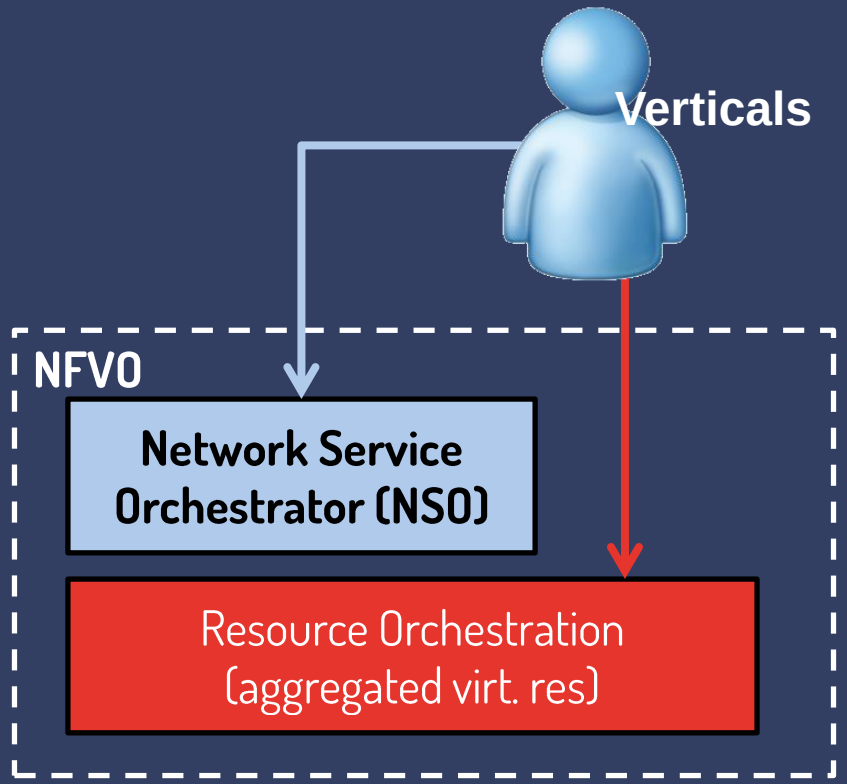


EU/5GPPP/ 5G Exchange – Resource Slice Programming



Key Messages #2: Business Implications

- Outreach to **verticals** (5G)
- (Industry) **automation**
  - Open standardized interfaces
  - Open software (open source)
- **Faster Time to Market** and **Flexibility**
  - Seamless combination of managed (VNFaaS) and self-operated VNFs



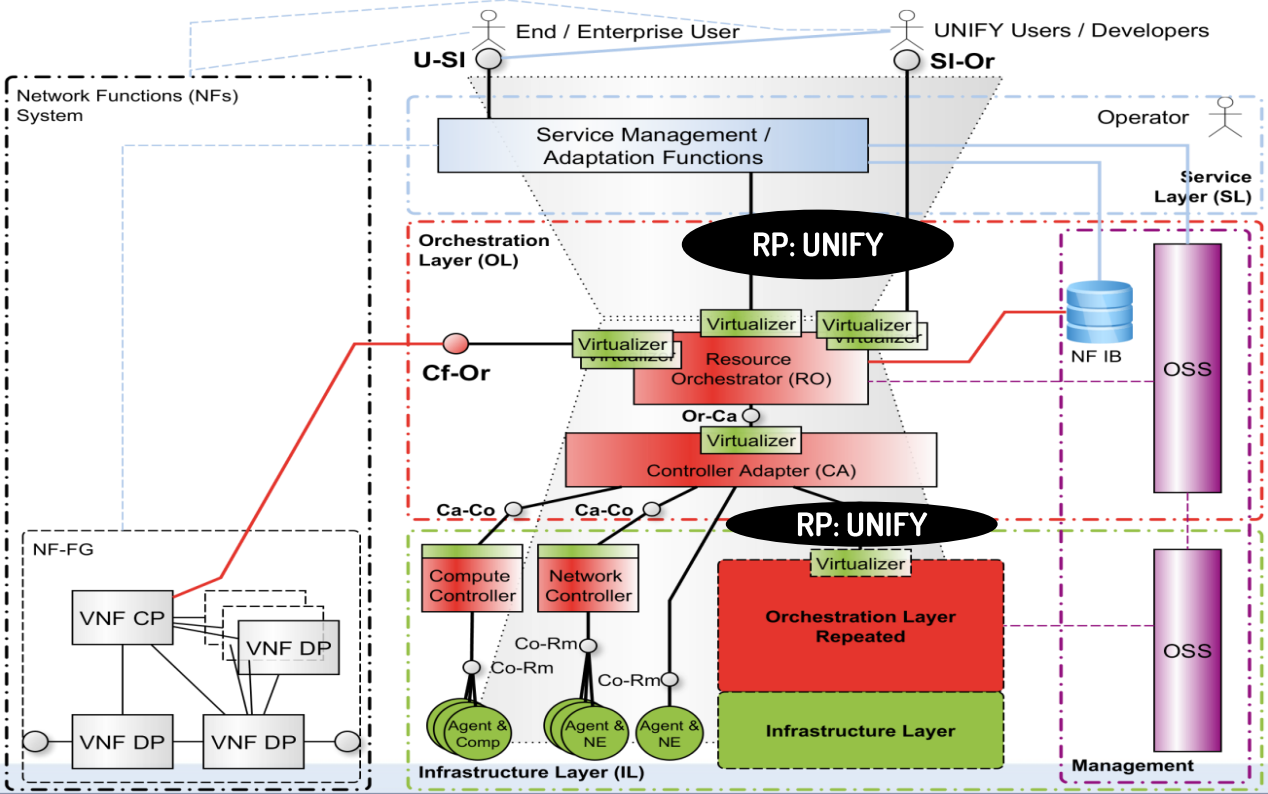
Technical Details

EU – FP7 UNIFY: Unifying Carrier and Cloud Resources

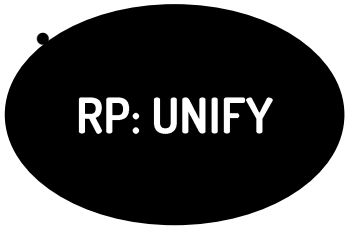
- ETSI NFV MANO Revived
- Implications
- Technical details
- UC-SFC
- Summary

UNIFY is co-funded by the European Commission
DG CONNECT in FP7

UNIFY Architecture (Overview)



- **NFV & SDN, as enablers**
- **Multi-level (recursive)**
- **Reference Points for NF-FG:**

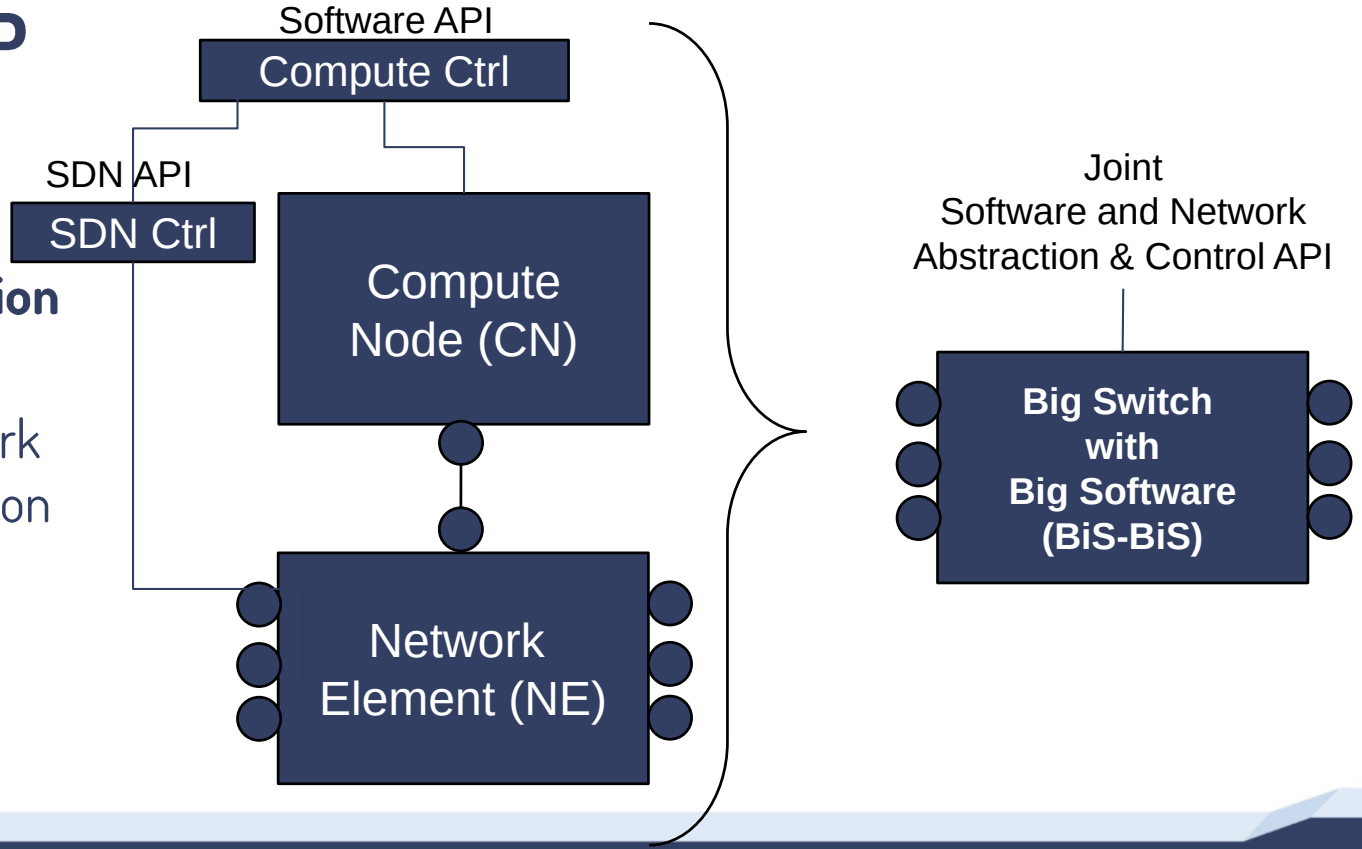


NF-FG: Network Function Forwarding Graph

UNIFY Virtualization & Control @UNIFY RP

Top of Big Switch & Big Software (BiS-BiS) virtualization

1. Combined software & network resource abstraction
2. Control API



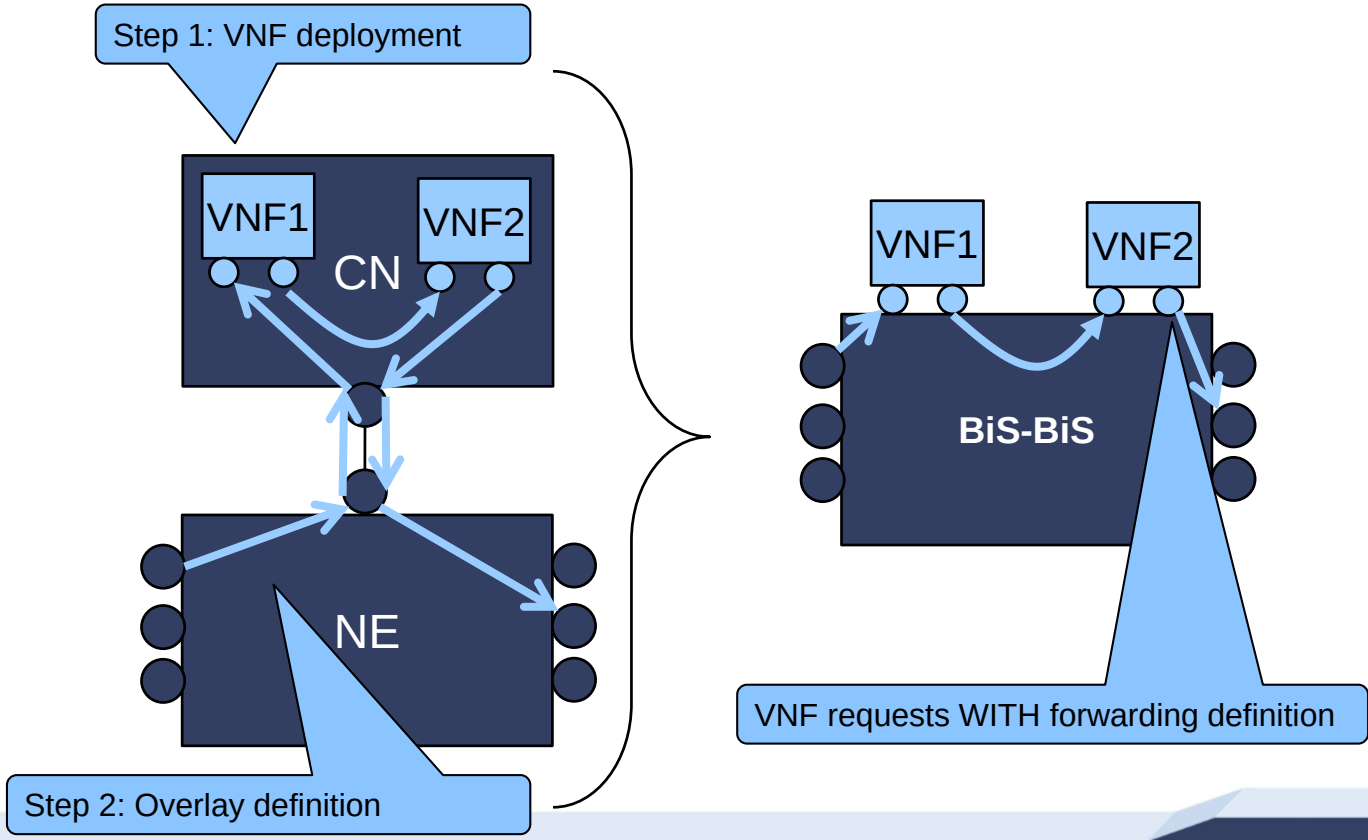
UNIFY Virtualization & Control

@UNIFY RP

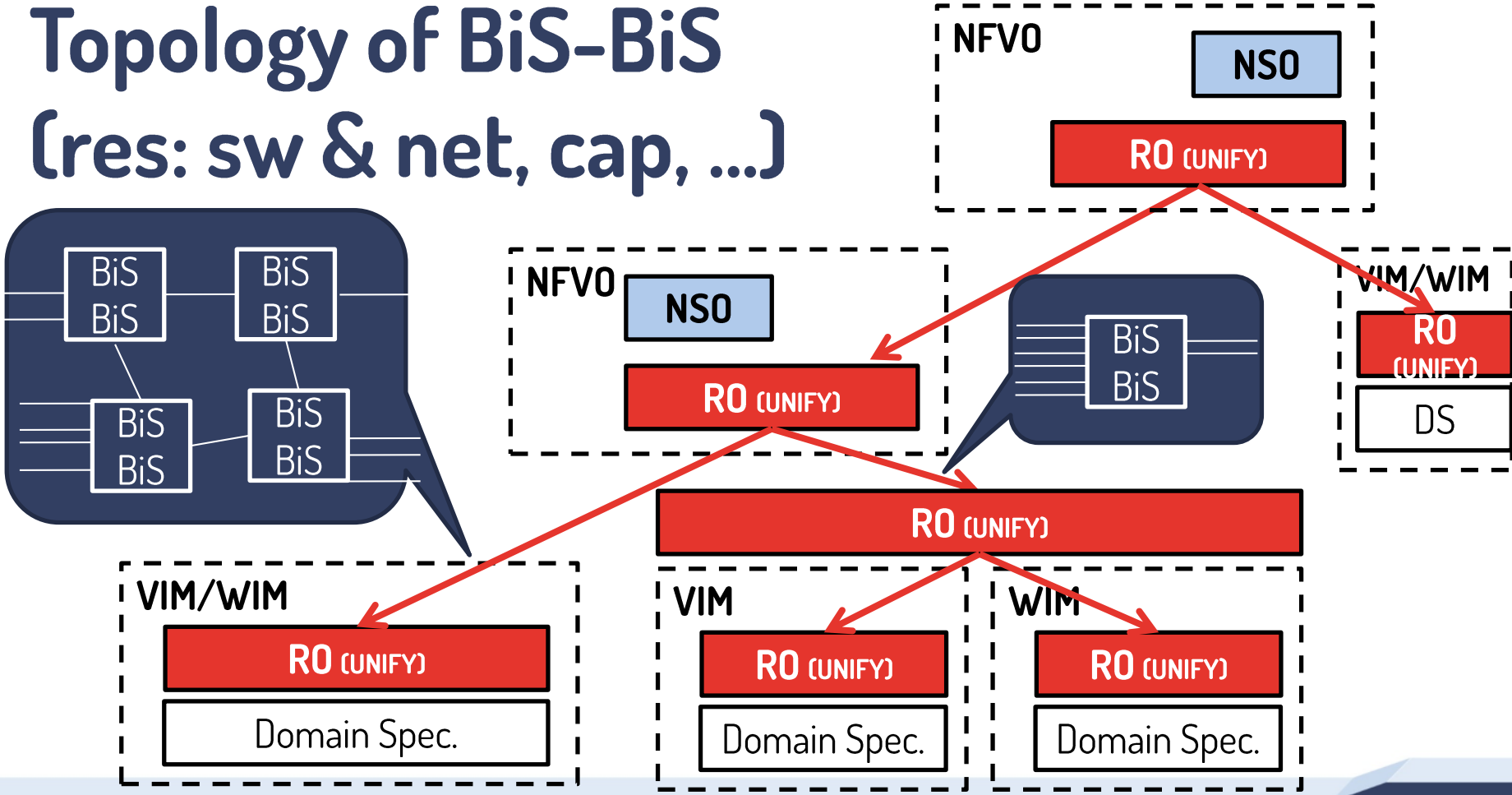
"**Atomic**" joint configuration of

1. VNF placements
   - Defines **ports**!!!

2. Forwarding definition

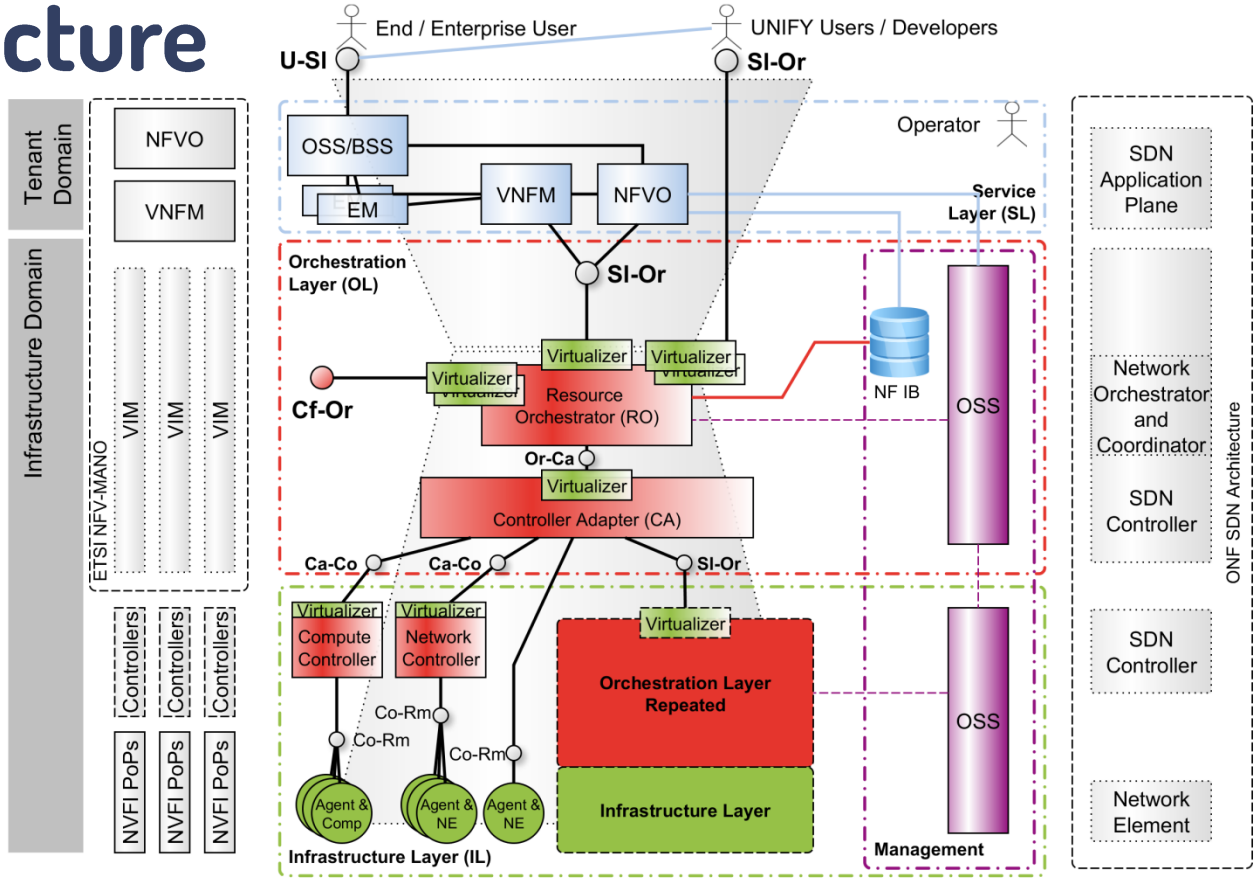


Topology of BiS-BiS (res: sw & net, cap, …)



UNIFY Architecture

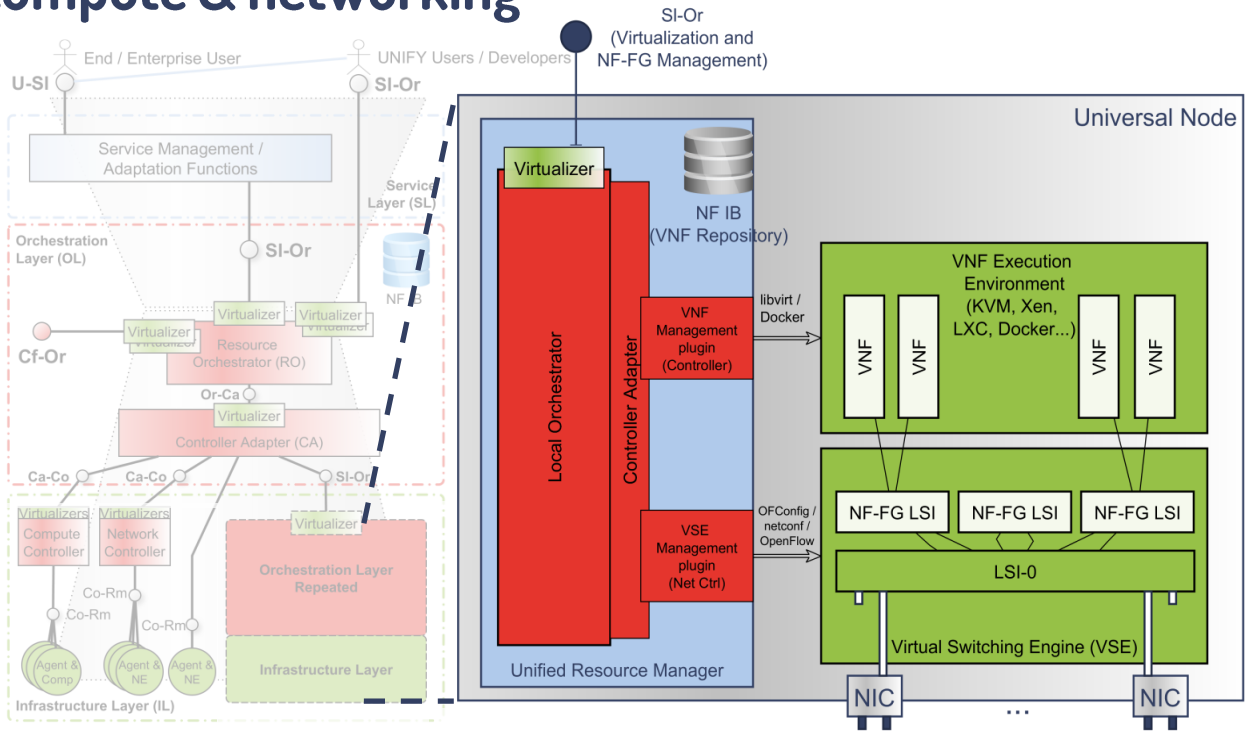
- Logically **centralized** resource orchestration
- **Joint software & network**
  - Virtualization
  - Programming
- Multi-level / recursive architecture



Universal Node (UN): the native BiS-BiS node

Bridging gap between compute & networking

- UN hosts VNFs as **full VMs**, **lightweight containers** or **enhanced logical switch instances**
  - **HW acceleration**
- Achieve **high performance** (e.g. by Intel® DPDK) in UN Virtual Switching Engine & optionally in various VNFs.



Physical networking, virtual networking (vSwitch) & VNF (compute) in the same node

Solution Additionally Features

- NF decomposition (e.g,. VNF => VNF-FG)
- Embedding algorithms with joint SW and Network optimization with constraints
- Multi-technology support
  - OpenStack, Docker, Click
  - OpenFlow NE, POX and Ryu SDN Controllers, (ODL)
  - "native" Universal Node
    - HW acceleration by decomposition
- CP-DP split / direct elasticity control [IEEE Network]

- Open-source proof of Concept Prototype demonstrations
  - SIGCOM 2014, 2015
  - EWSDN 2015
  - BBF 2016 Q1
  - ETSI, May 2016
  - *See you at* ***IETF96 Bits'n'Bites***

Key Messages #3

IT WORKS
-- OpenSource PoC prototypes

- Data model published at IRTF / NFVRG
- ETSI NFV compliant solution with NFVO and VIM (like a middleware)
- Integrating and “packaging” for IETF Bits-N-Bites @Berlin

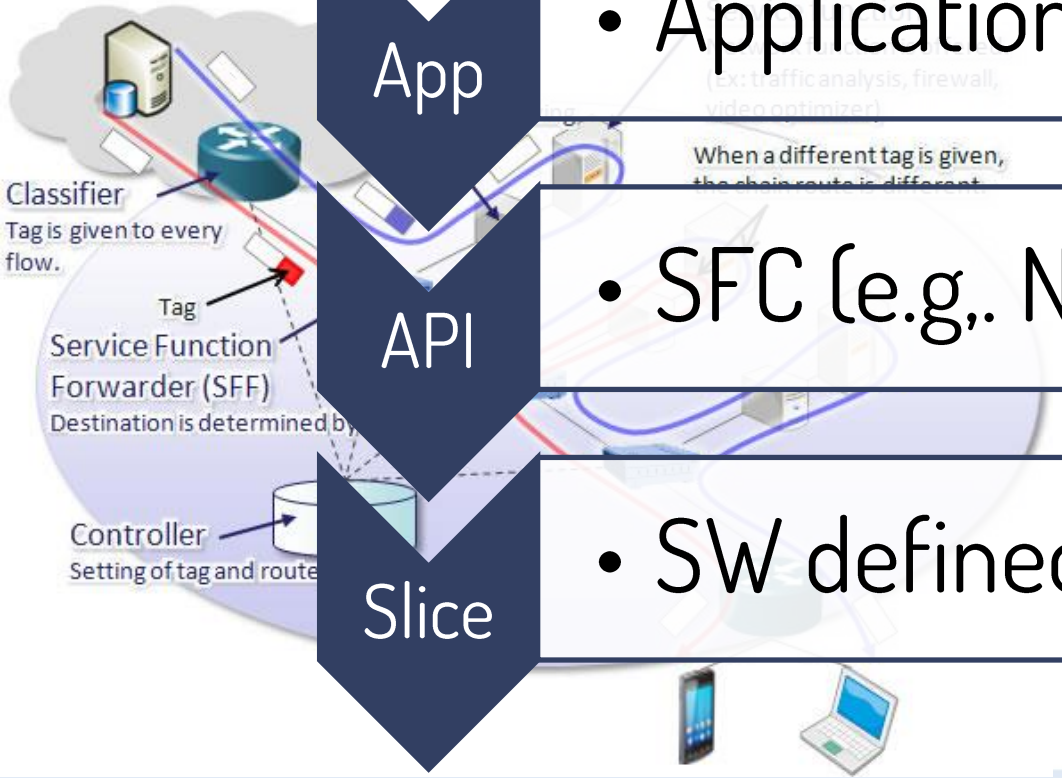
Service Function Chaining

Revived?

- ETSI NFV MANO Revived
- Implications
- Technical details
- UC-SFC
- Summary

UNIFY is co-funded by the European Commission
DG CONNECT in FP7

“World’s first demonstration of interoperability of new IETF method for service chaining involving six companies” -- February 12, 20[illegible], source: NTT http://www.ntt.co.jp/news2015/1502e/150212a.html



App

- Application (Software)

API

- SFC (e.g,. NFV and SDN)

Slice

- SW defined NW Slice

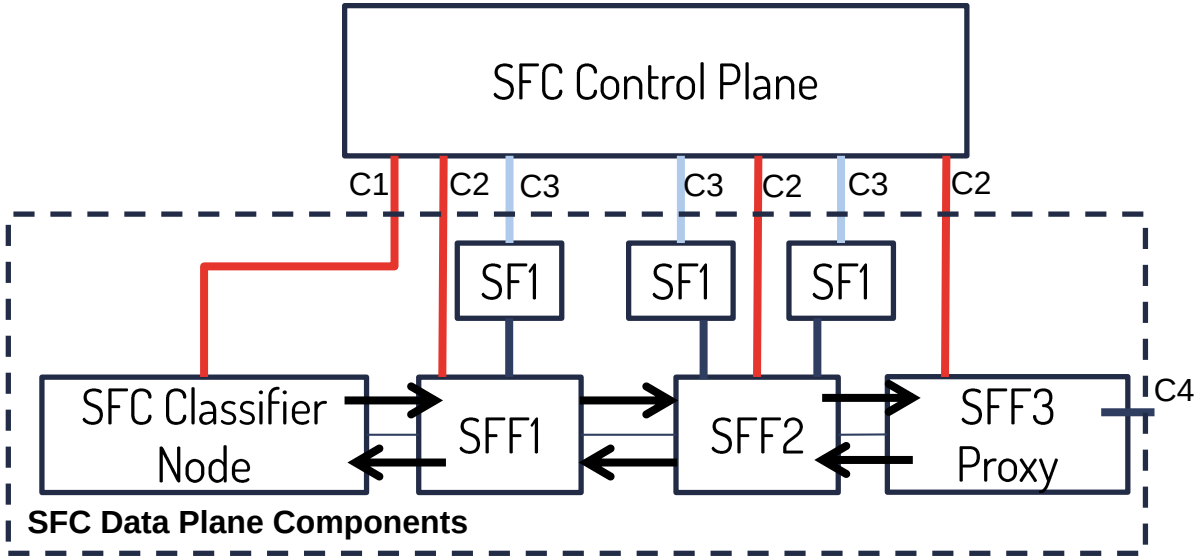
Applications

Virtual Distributed System

Physical distributed system

SFC Architecture

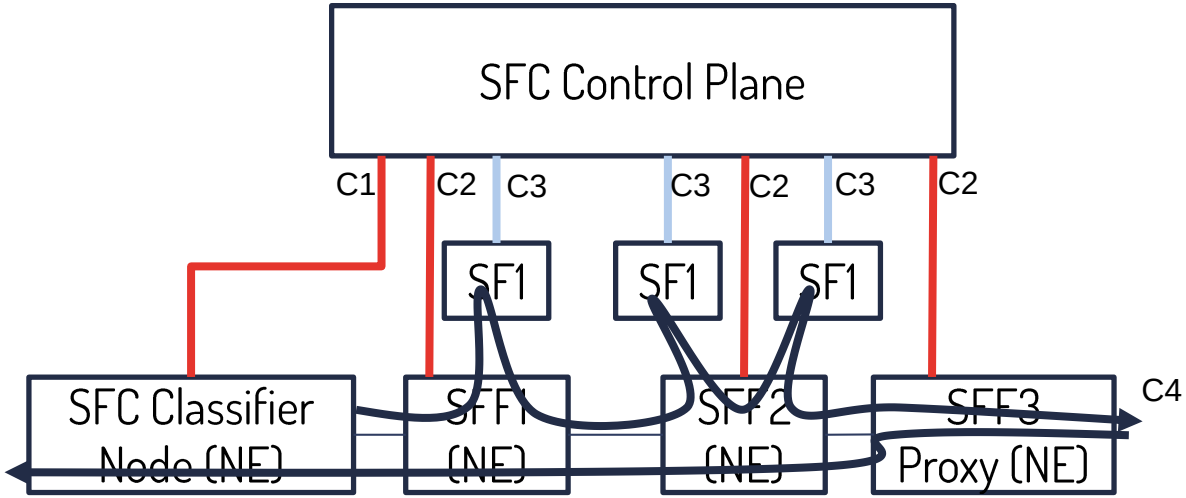
- SF: Service Function
- SFF: Service Function Forwarder
- Control interfaces
  - C1 – Classifier
  - C2 – SFF
  - C3 – SF
  - C4 – SFC unaware SFs



Ref: [I-D.ietf-sfc-control-plane]

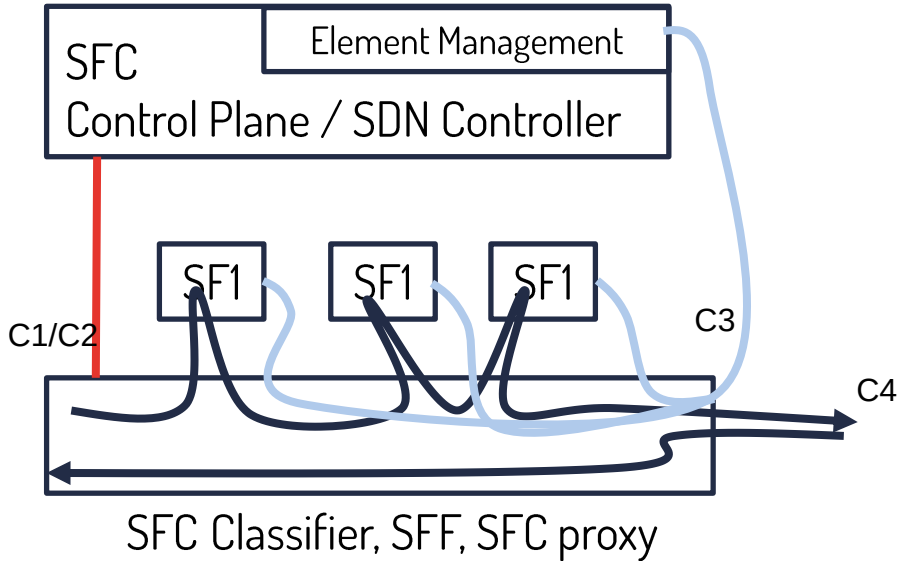
SFC with SDN NEs

- NE : Network Element
- Mind
  - C1, C2: SDN Control
  - C3: Element Management



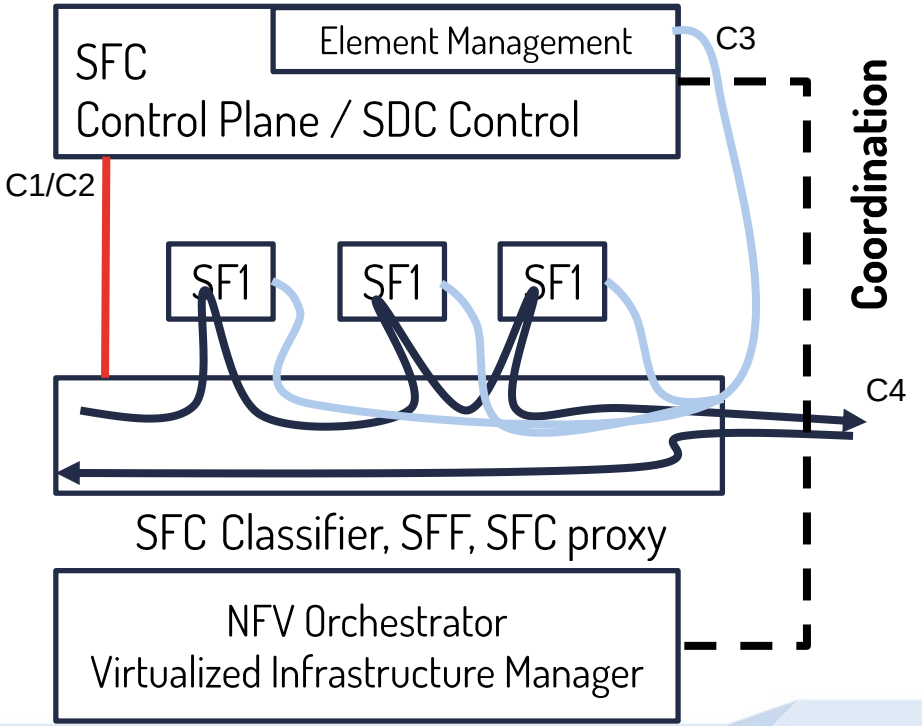
Steering Control (C1/C2) vs SF Configuration (C3)

- SFC Control Plane decomposed
  - SDN Controller
  - Element Management
- Mind
  - **User Plane** vs **Management Plane** traffic is **situational only**, handled the same



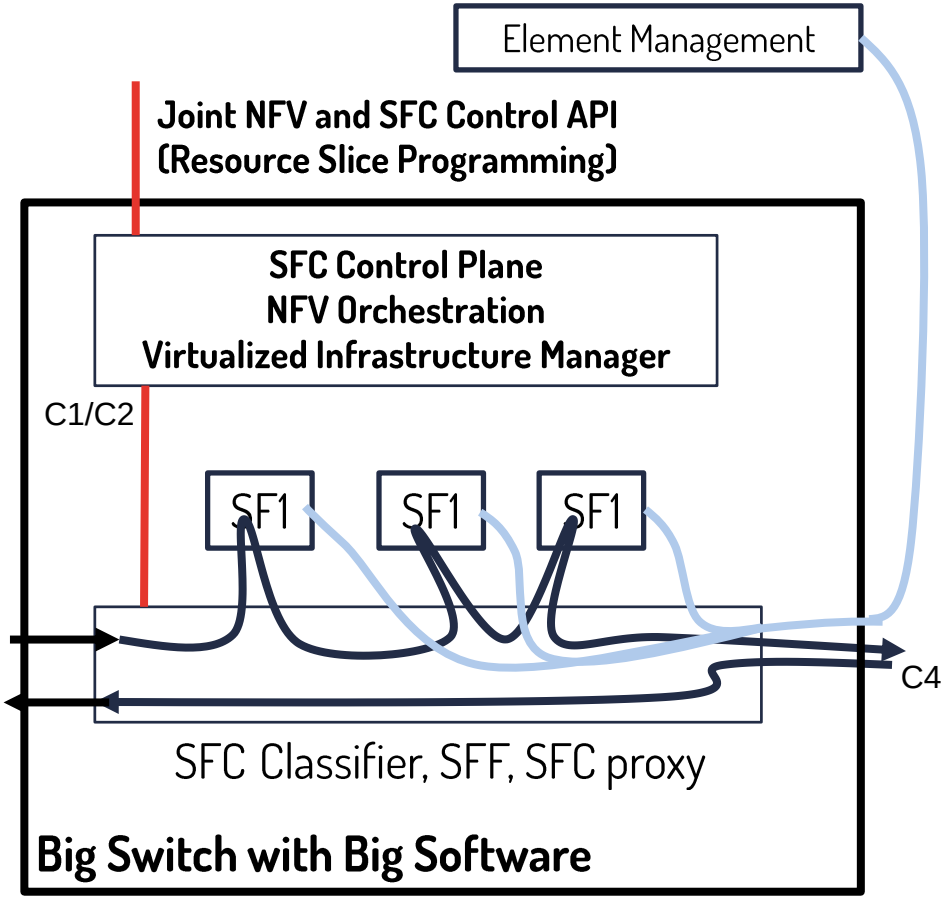
How SFs get Deployed?

- SDN
  - Once there; SFs are just resources (aka port)
- NFV
  - i) SFs go to the cloud, then ii) interconnect ➔ overlay
- Combination needs **coordination**
  - Not defined!!!

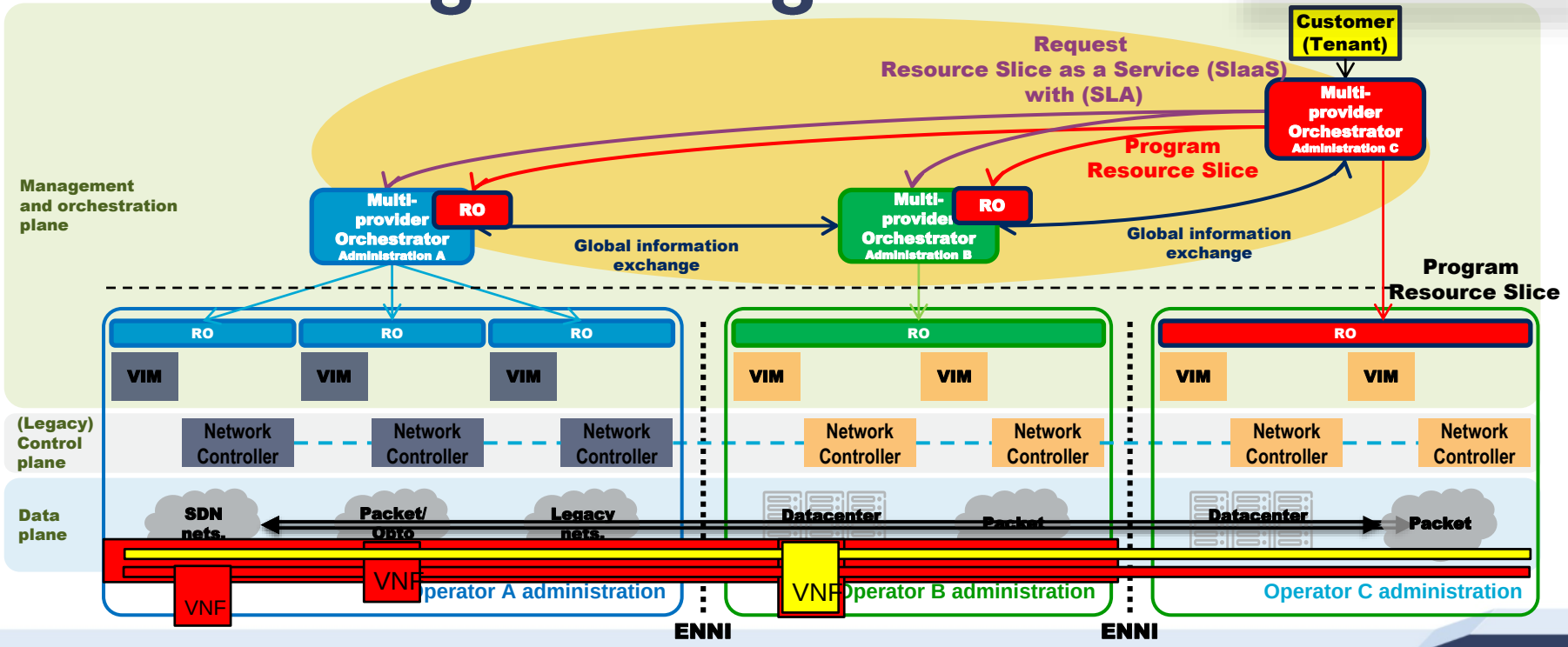


Joint SW and Network Abstraction and Programming API

- Straightforward combination
- Can describe single node, nodes, domains, administrations, …



Resource Slice Programming == SFC Programming ?!



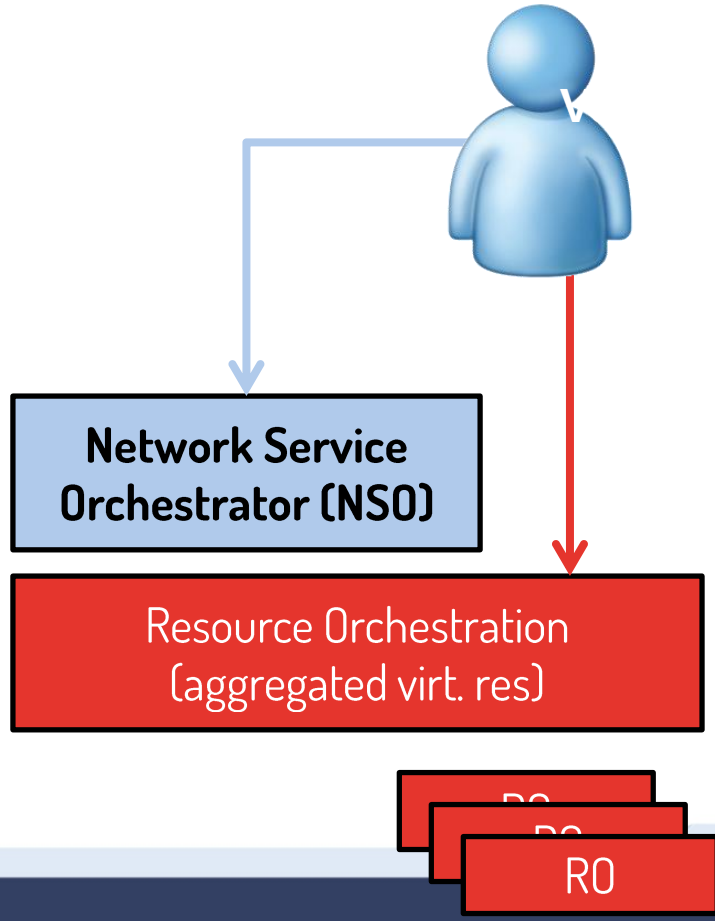
Key Messages #4

Joint Software and Forwarding Abstraction

- Integrates SDN and NFV
- Provides an SFC Control Plane
- Defines a programmatic interface for network slicing

Summary

1. A **different functional split** of the ETSI MANO architecture
2. **Joint** Software and Forwarding **Abstraction**
3. **Open Source PoC** implementations
4. Outreach to verticals, **automation**, faster TTM
5. SW Apps ➔ Service Function Chaining ➔ Network Slice



EU FP7 UNIFY: Acknowledgement

UNIFY consortium (Nov 2013 – July 2016)

This work is supported by FP7 UNIFY, a research project partially funded by the European Community under the Seventh Framework Program (grant agreement no. 619609). The views expressed here are those of the authors only. The European Commission is not liable for any use that may be made of the information in this document.

Major Service Providers:

Deutsche Telekom

TELECOM ITALIA

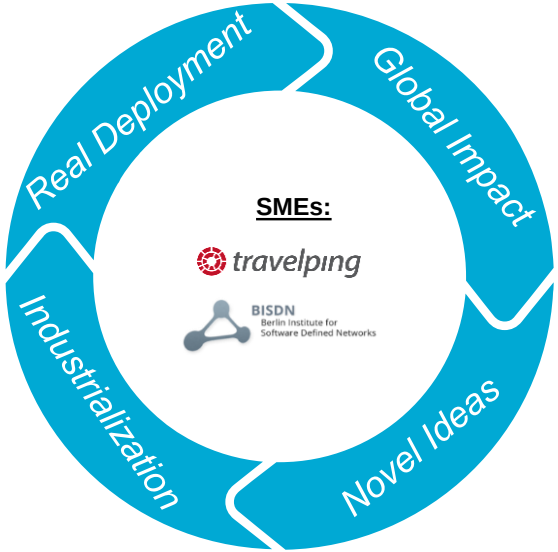
OTE

Research Institutes:

iMinds CONNECT.INNOVATE.CREATE

SWEDISH ICT SICS

acreo



Project Management: eict

Major Vendors:

ERICSSON intel

Coordinator

Universities:

MŰEGYETEM 1782

Universidad del País Vasco Euskal Herriko Unibertsitatea

EU 5G-PPP: 5G Exchange (5GEx) (Oct 2015 – May 2018)

This work is partially supported by 5G-PPP 5GEx, an innovation action project partially funded by the European Community under the H2020 Program (grant agreement no. 671636). The views expressed here are those of the authors only. The European Commission is not liable for any use that may be made of the information in this presentation.

Extra: Demo Use-case

A simple robotics app

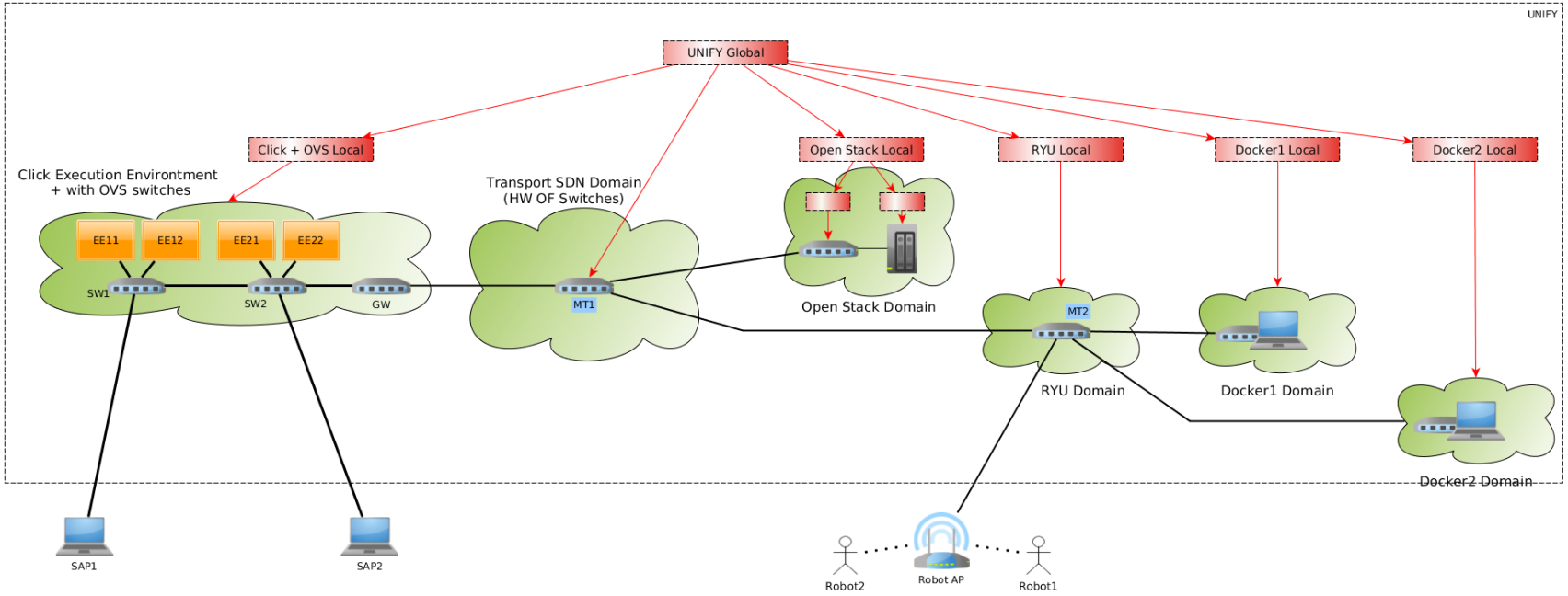
- ETSI NFV MANO Revived
- Implications
- Technical details
- UC-SFC
- Summary

UNIFY is co-funded by the European Commission
DG CONNECT in FP7

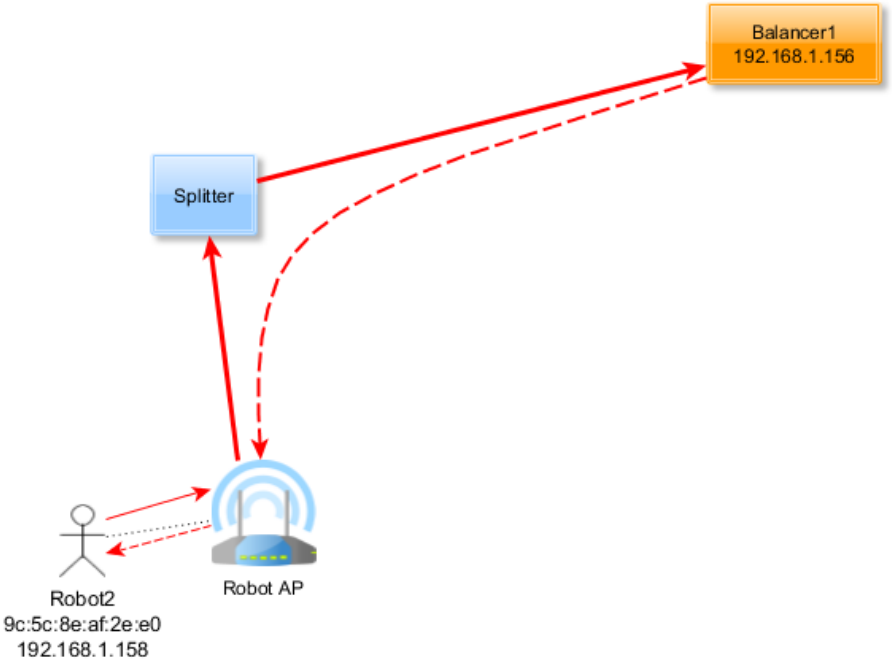
SW App for the Lego Mindstorm Gyroboy

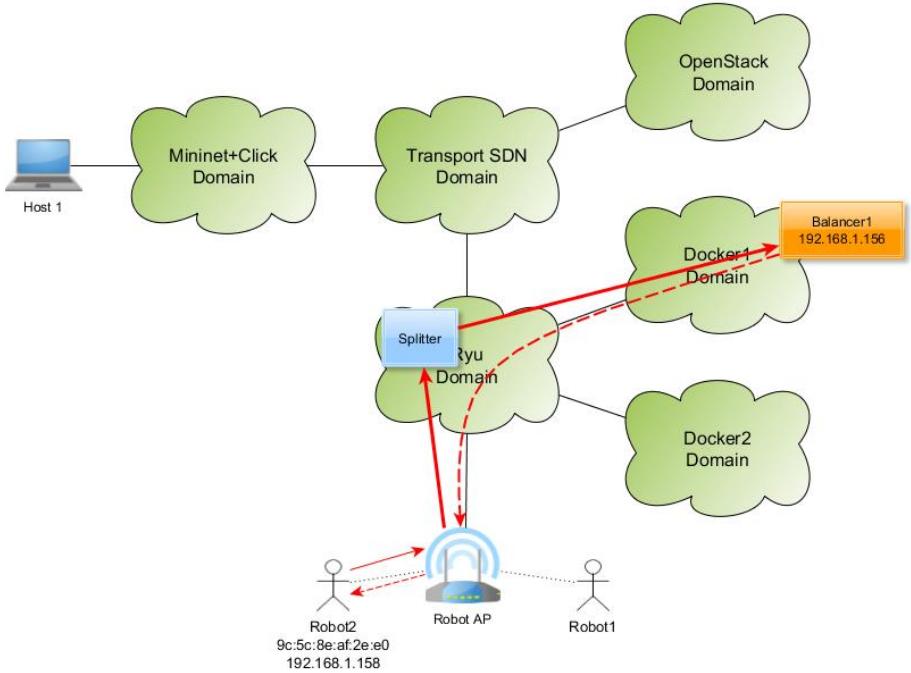
- Sensors and Servos @Robot
- Balancing PID Controller @NetworkCloud
- Requirements: **RTT < 40 msec**
  - Edge Computing
- **Goals**
  - **Slice programming, flexible service creation, automation, fault tolerance**
    with a real – industry like - use-case
  - Learn how (SW+NET) API influence the SW APP design

PoC Testbed

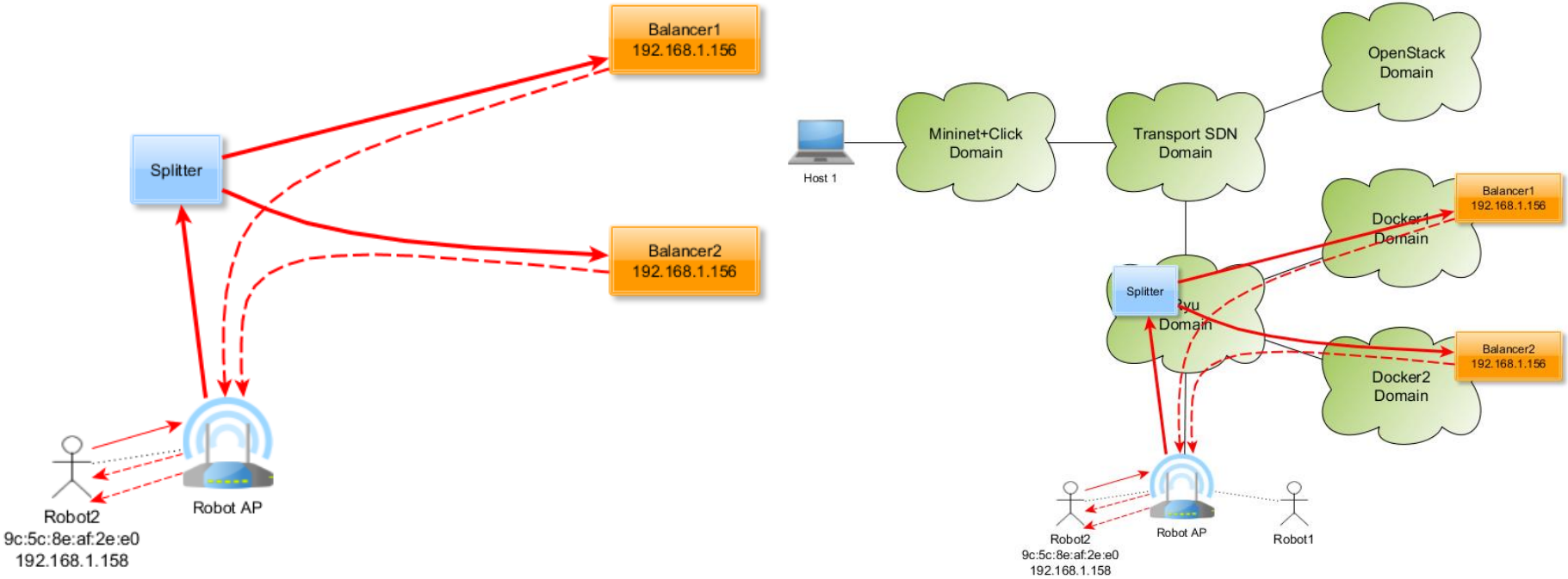

UNIFY
UNIFY Global
Click + OVS Local
Open Stack Local
RYU Local
Docker1 Local
Docker2 Local
Click Execution Environtment
+ with OVS switches
Transport SDN Domain
(HW OF Switches)
EE11
EE12
EE21
EE22
SW1
SW2
GW
MT1
MT2
Open Stack Domain
RYU Domain
Docker1 Domain
Docker2 Domain
SAP1
SAP2
Robot2
Robot AP
Robot1

SW ➔ SFC ➔ Network Slice

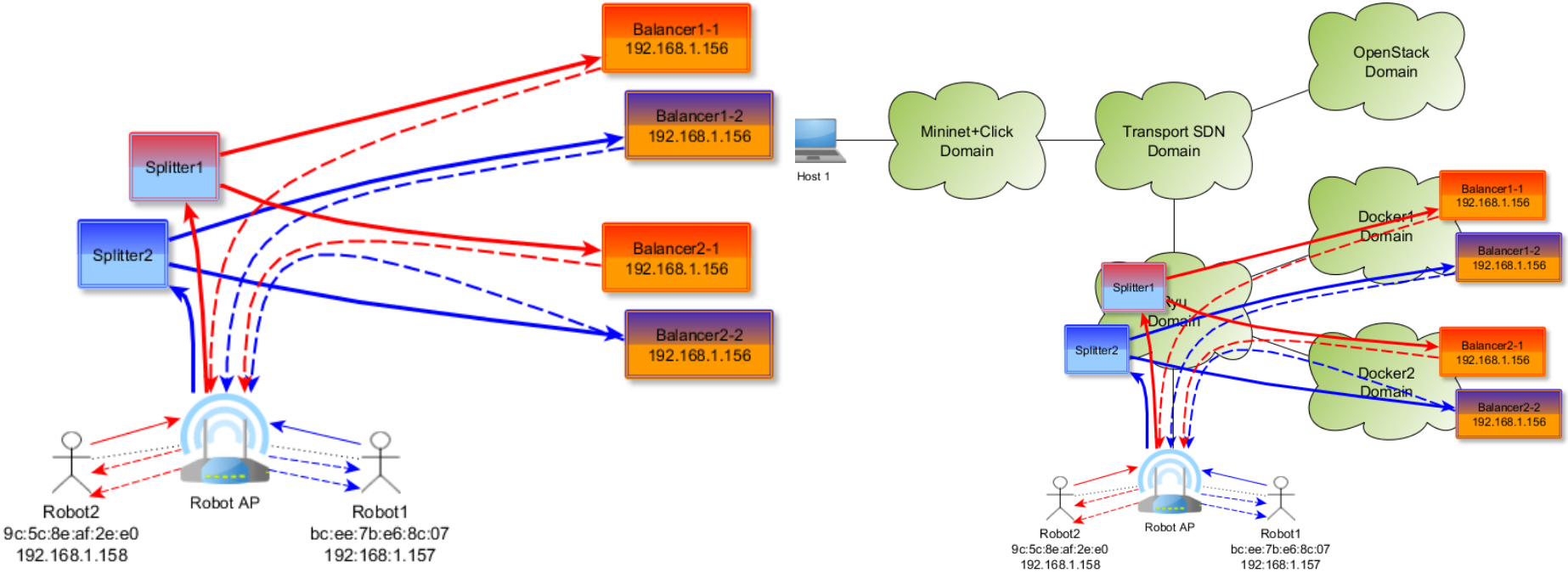




SW ➔ SFC ➔ Network Slice



SW ➔ SFC ➔ Network Slice



Lego Balancing Conclusions

- Robust SW App design + (SW+Net) programming allow flexibility in service creation
- State sharing / migration
- Full cloning of the SF (incl. MAC + IP) solved ARP issue

Summary

1. A **different functional split** of the ETSI MANO architecture
2. **Joint** Software and Forwarding **Abstraction**
3. **Open Source PoC** implementations
4. Outreach to verticals, **automation**, faster TTM
5. SW Apps ➔ Service Function Chaining ➔ Network Slice