

GNA

Network Virtualization

Architecture

The vision, progress, and trajectory

Jerry Sobieski
NORDUnet CRO
Jerry@nordu.net

What do we mean by Virtualization?

- “Virtualization” is the *abstraction* of network services and components away from specific hardware or specific products/features
 - We create a set of behavioural *service specifications*
- Abstracted virtual service objects are technology agnostic - i.e. common global service objects can be defined via community consensus, but each service provider can implement those virtual services as they see fit.
- And because VObjects are not tied to specific hdw, they can be realized where-ever and whenever they are needed.

Why a Virtualization Architecture?

- Network services are becoming increasingly virtualized
- Network resources are increasingly integrated into user applications and under user control in ways that challenge the capabilities of our present service models
 - E.g. NDN, Global Research Platform, security, privacy, DTNs, md automation & orchestration
- To date, virtual objects are offered randomly with few common rules for specification, management, or to enable automation/orchestration – this makes it difficult to build shared community automated software systems to support them.
- The GNA requires ability to support multiple service environments simultaneously, extending seamlessly across multiple infrastructure domains, both new experimental services as well as mature reliable services,
- The GNA chartered the [Network Virtualization Architecture Working Group](#) to address this issue – to develop a consensus model for how virtualization can be adopted and leveraged in the global R&E network.

The GNA Network Virtualization Arch WG and the Generic Virtualization Model (GVM)

- The WG was established in Spring 2018
 - Initial participants: NORDUnet, Esnet, GEANT, DFN (DE), Internet2, MAX (US)
 - It is expanding: RNP, SINET/Univ of Tokyo, ...
- The WG has two main objectives:
 - Define an end-to-end deterministic virtual circuit model
 - Define a comprehensive virtualized network architecture within the context of GNA
- The WG has settled on a basic concept called the Generic Virtualization Model (GVM)
 - The SENSE Intent based concepts explored by ESnet, and the GTS virtualization explored by GEANT got the most attention and were felt to address the R&E requirements best.
 - Both models leveraged NSI concepts of technology agnostic, opaque services, lifecycle, end-to-end, ...

Generic Virtualization Model (key elements)

Everything is a virtual object

Ex: VMs, Vswitch, LoadBalancer, etc

All services are delivered via virtual objects

How a virtual object is implemented in the infrastructure is opaque and **technology agnostic**

All virtual objects have a common LifeCycle:

they are **reserved**,

they are **activated**,

they are **deactivated**,

they are **released**,

And they can be **queried**

Virtual objects are defined as **Classes**, or types of object – e.g. VM, VC, Firewall, Encryptor,...

A class may define an “**atomic**” object, or it can define a “**composite**” object.

A class has a name, and a behavior – what the user can expect the object to do

“**Atomic**” classes cannot be decomposed – they are manipulated by lifecycle software agents specific to that class.

Each atomic class has common set of characteristics:

Some **attributes** specific to the class – e.g. amount of memory for a VM class.

And a set of I/O **ports** that allow an object to exchange information with other virtual objects

The virtual model must support “**composable**” services, or “**composite**” virtual objects that contain:

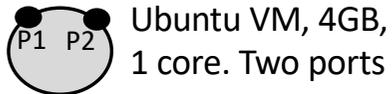
The “**children**” virtual objects that make up the composite object

The I/O port interconnections – **adjacencies** - that define data flow topology, or the functional service graph

Atomic Resources, Composite Resources

From atomic resources to running network slice

“Host” atomic class:

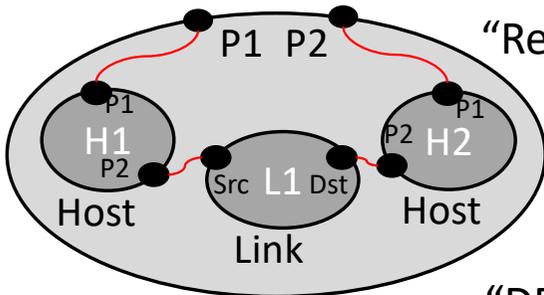


“Link” atomic class:

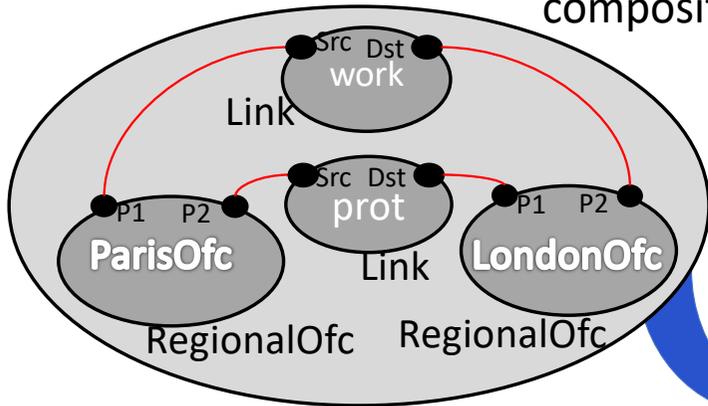


“RegionalOfc” composite class

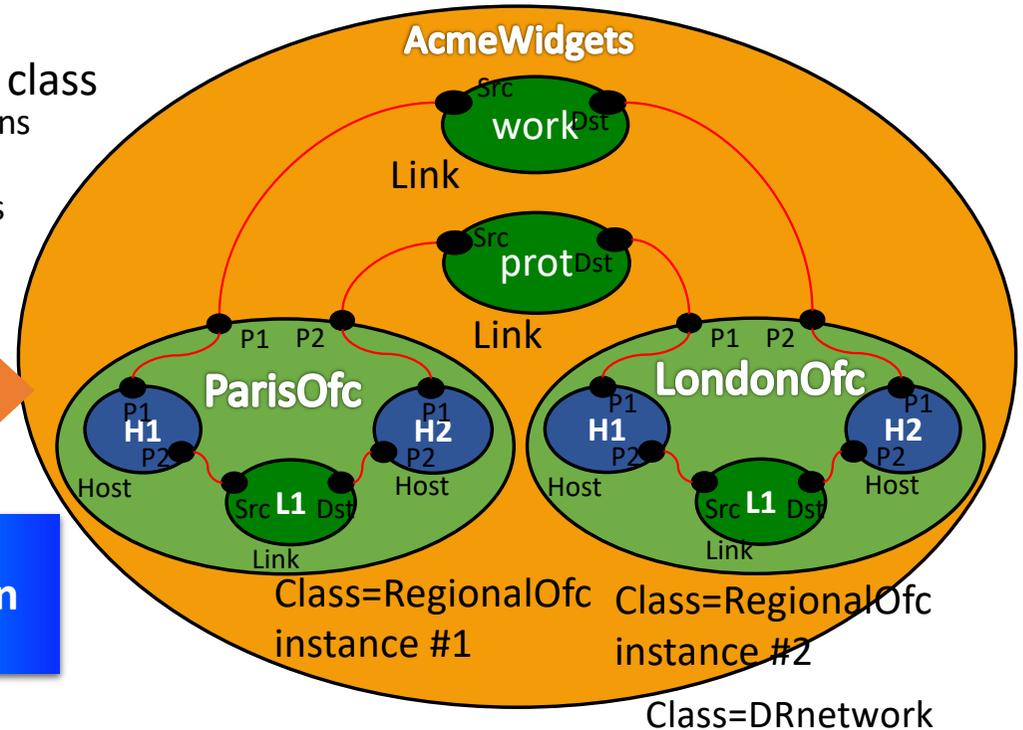
A composite resource contains other Resources, external ports, and port adjacencies



“DRnetwork” composite class



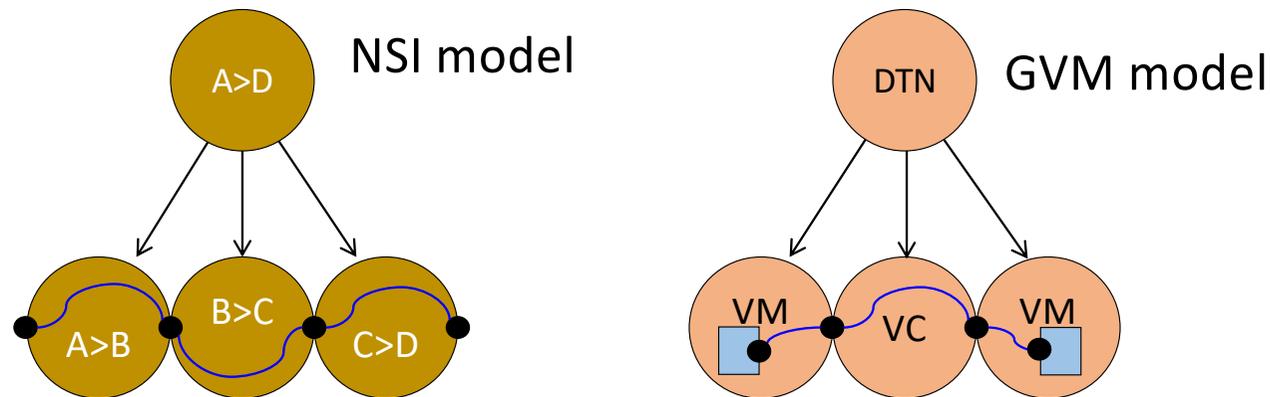
Instance of class “DRnetwork” named “AcmeWidgets”



Global Virtualization Service

The GNA Virtualization adopts key concepts from the NSI standards:

- Segmentation ... Hierarchical [de]composition



- The NSI “service tree” set the stage for hierarchical composition – the ability to define “composite” service objects that are groups of other more atomic service objects

The GNA Virtualization model adopts/extends key concepts from the NSI standards:

- Abstract service objects (technology agnostic service definitions) applied beyond just “connections”

NSI Connection	GVM Virtual Machines	GVM Virtual SDN Switch	GVM Bare Metal Server	GVM Composite	Other...	Class/Type
Capacity Jitter MTU FER	Location MemSize Cores Ports ISOimage	Location Ofversion Hard/Soft ControllerAddr	Location MemSize Cores ClockSpeed ISOimage	Children Adjacencies ...	Class specific Attributes	Attributes
Src, Dst	Port{1..n}	Port{1..n}	Port{1..n}	Port{1..n}	Ports	data flow ports

The GNA Virtualization adopts key concepts from the NSI standards:

- Lifecycle model

NSI	Generic virtualization model
Reserve()	Reserve()
Provision()	Activate()
Query()	Query()
Release()	Deactivate()
Cancel()	Release() (equivalent to NSI Cancel)

- GVM lifecycle primitives are semantically identical to NSI life cycle...just different primitive names.

GNA NVA wg Future Trajectory

- A document summarizing the **Generic Virtualization Model** and some sample use cases is in draft, **TBR ~ Nov 2019**.
- **The WG is moving ahead to deploy virtualization services** (a Global Virtualization Service – GVS) in EU, SA, and NA, and other locations this fall and next spring
- These GVS deployments will demonstrate the Use Cases identified in the WG document.
 - End to End (multi-domain) *Deterministic* Virtual Circuits
 - Multi-point global broadcast domain with optimized switching placement
 - PIMP-my-Circuit Open eXchange Point AAI services
 - Cloud-To-Campus service integration
 - Web services Load balancer with packet
- It looks also like the **NSI WG will be looking at GVM as the basis for NSI v3** (this effort just starting)

The Vision

- The Network Virtualization Architecture WG sees virtualization as a foundational concept for all e-infrastructure
 - There is too much flexibility and cost efficiencies to ignore this – and this is just as true for the network as other e-infra providers
 - There is no performance penalty
- We need to work with other e-infra providers (compute, storage, instruments, sensors) to demonstrate a common virtualization model works and opens a new chapter in E-infra automation and orchestration.
- Users (this includes network service providers) will construct their service from the “glass cockpit” and be able to deliver new capabilities into service in minutes rather than weeks or months.

The End

- FFI:
- Jerry Sobieski. jerry@nordu.net
- Skype: jerry.sobieski