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# 1 Summary

## 1.1 Federation by SEP (Slice Exchange Point)

### (1) Problem

- (a) Differences on Control-plane , Data-plane, Services, etc
- (b) Applying on federation-unconscious infrastructure (e.g. VNode)

### (2) Advantages

- (a) Introduction of "common API"
- (b) GK manages everything: less impact on current infrastructure
  - API translation: between common APIs and testbed-original APIs  
(commands, sequences, parameters, etc.)
  - Data-plane conversion

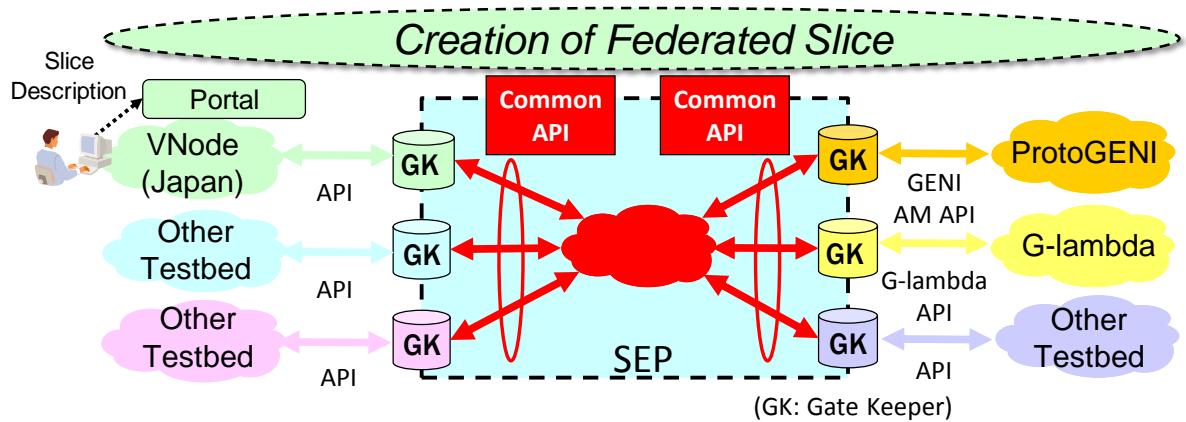


Fig. 1.1-1 Slice Exchange Point

## 1.2 Control-plane federation Architecture

- Cross-domain slice definition submitted to one domain
- Gate Keepers (GK) convert domain-specific commands, slice definitions to/from the common API
- Data Planes are connected by Gateway (GW)

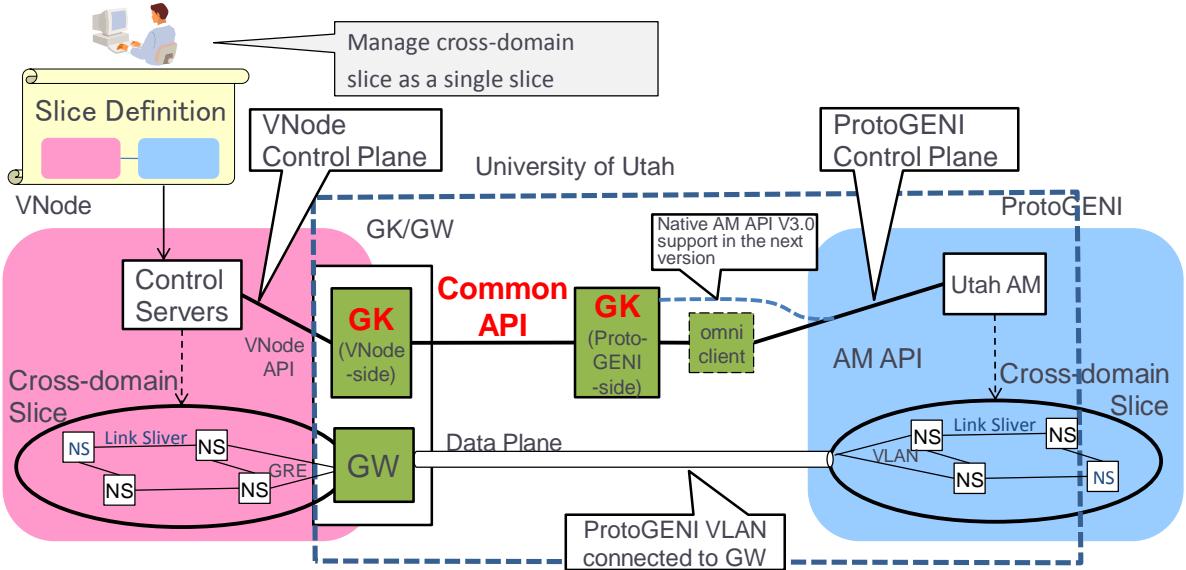


Fig. 1.2-1 Control-plane federation Architecture

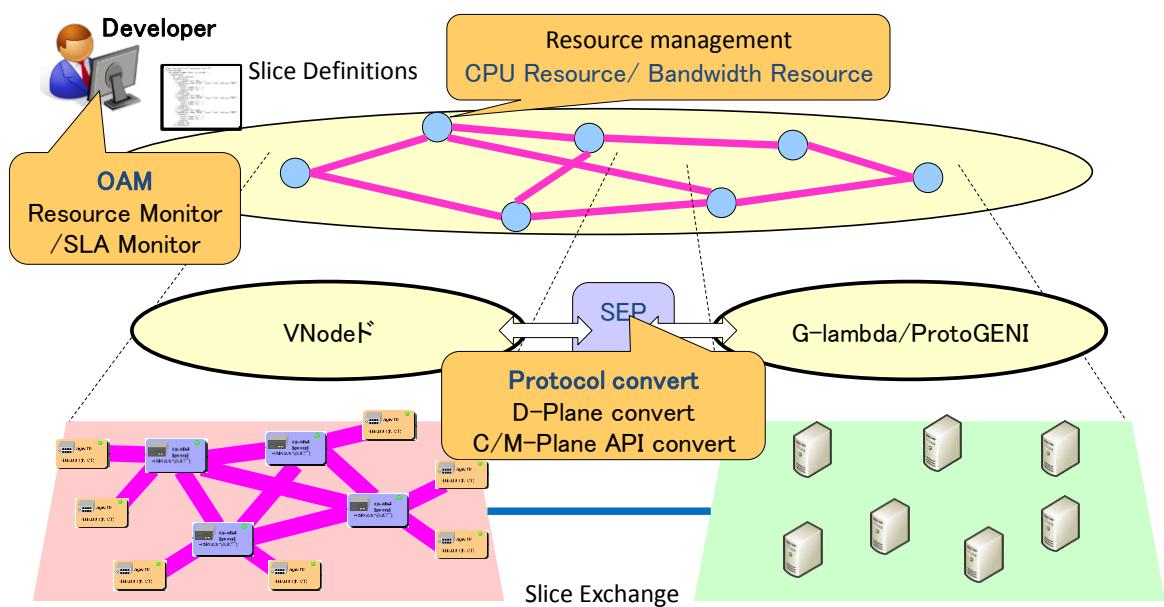


Fig. 1.2-2 Federation

### 1.3 Federation Execution Sequence

- ① Submit Slice Definition
- ② Convert VNode API (commands, slice definitions) to the common API
- ③ Convert the common API to ProtoGENI API and send it to the Utah AM
- ④ Create slice in each domain
- ⑤ Reply the information (VLAN ID) of cross-domain data plane
- ⑥ Connect data plane (by setting ProtoGENI's VLAN ID to GW)

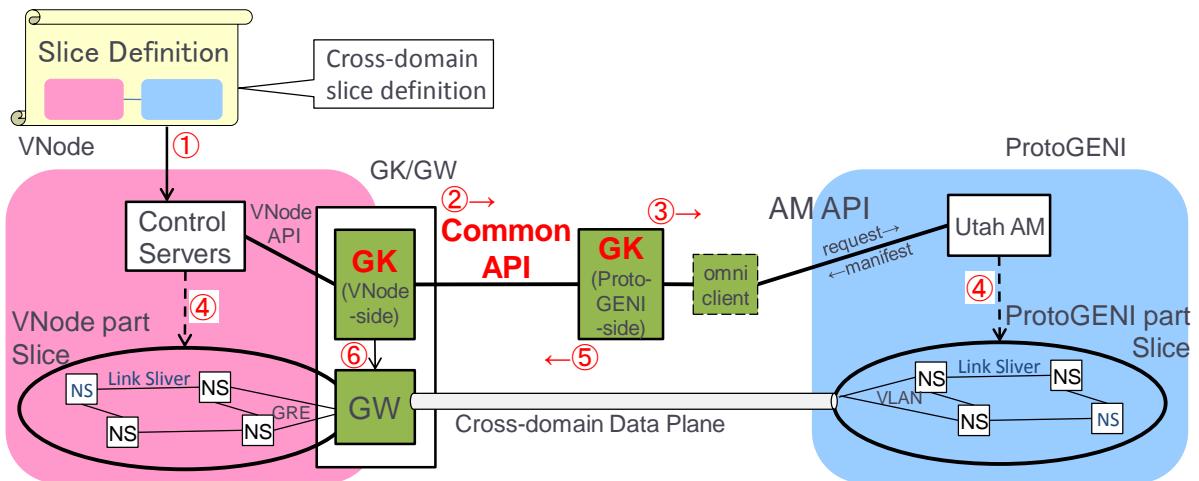


Fig. 1.3-1 Federation Execution Sequence

## 2 Gate Keepers (GK)

### 2.1 GK

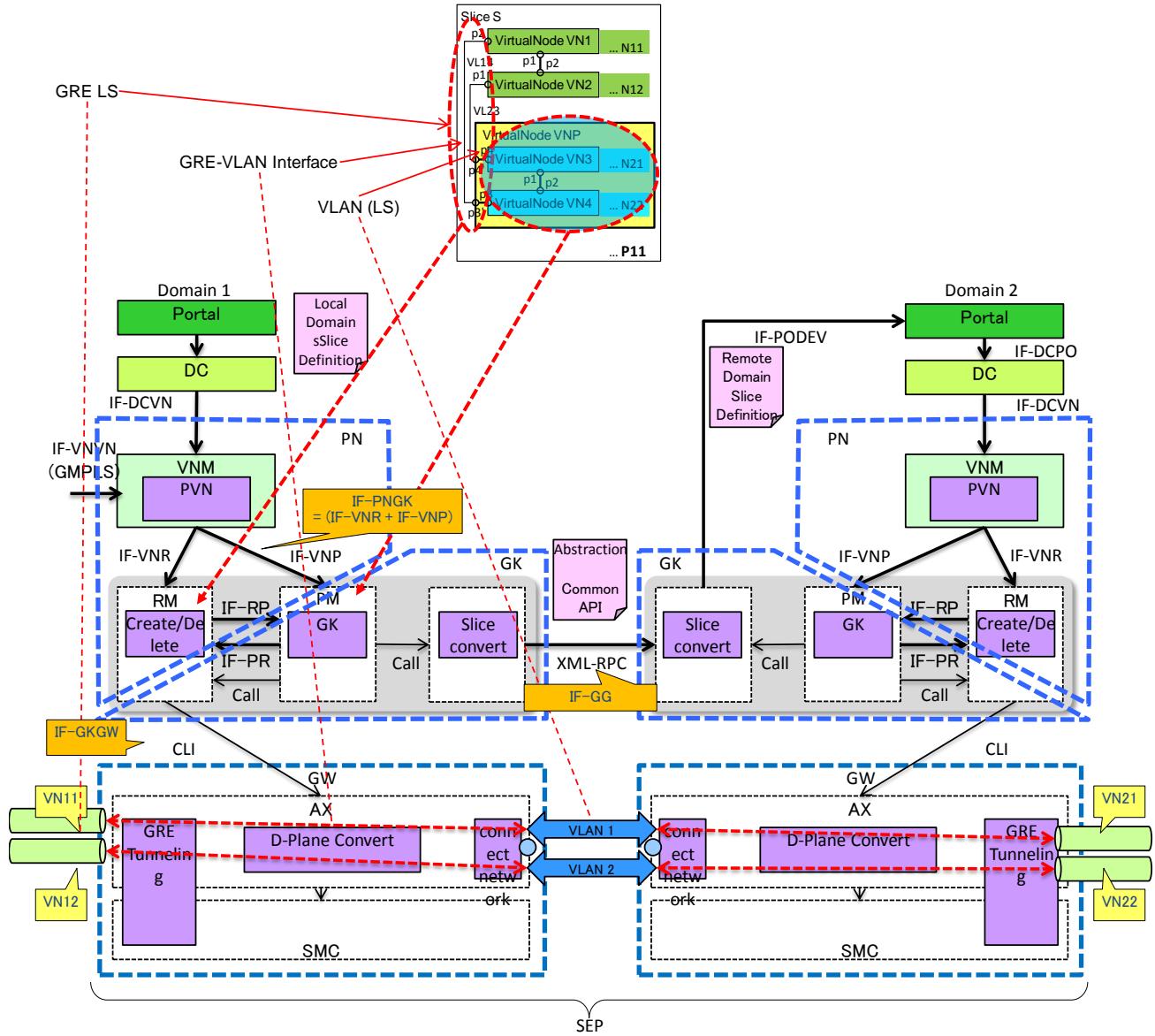


Fig. 2.1-1 Gate Keepers (VNode – VNode)

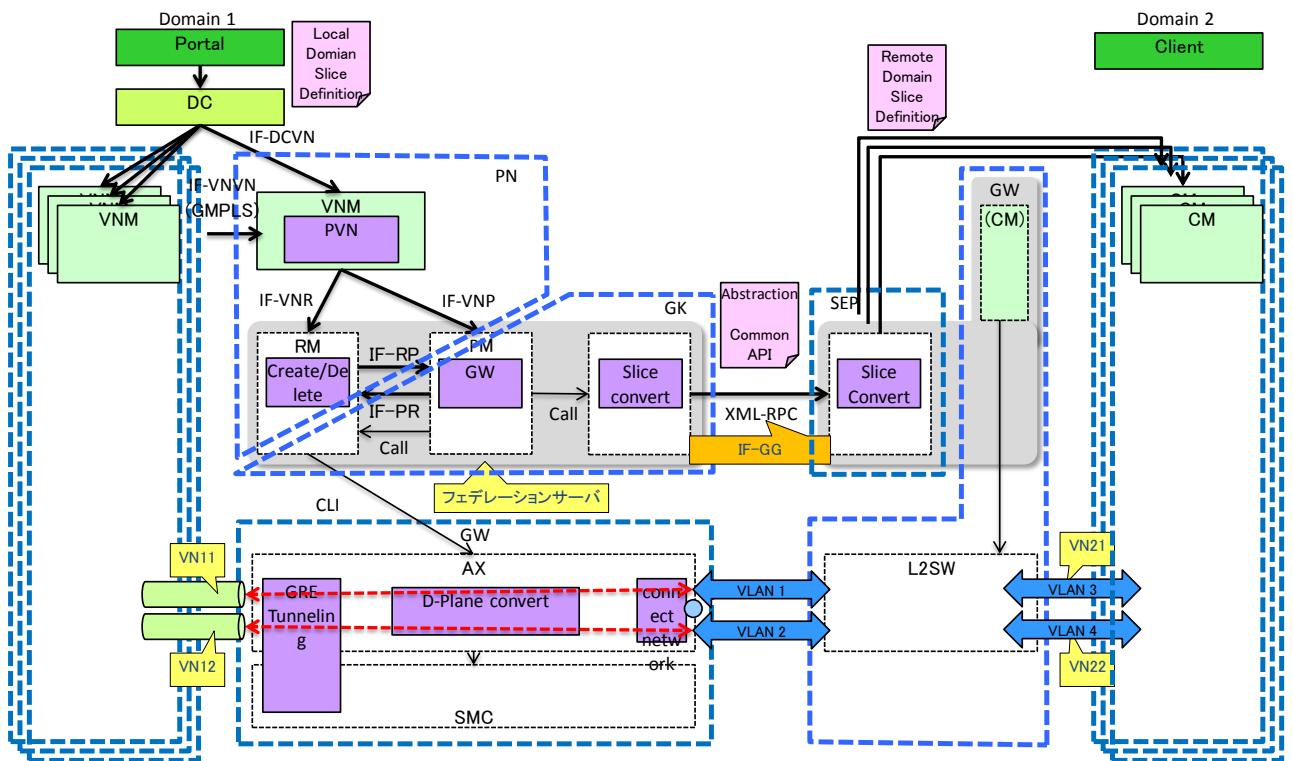


Fig. 2.1-2 Gate Keepers (VNode – ProtoGENI)

## 2.2 Multiple domains

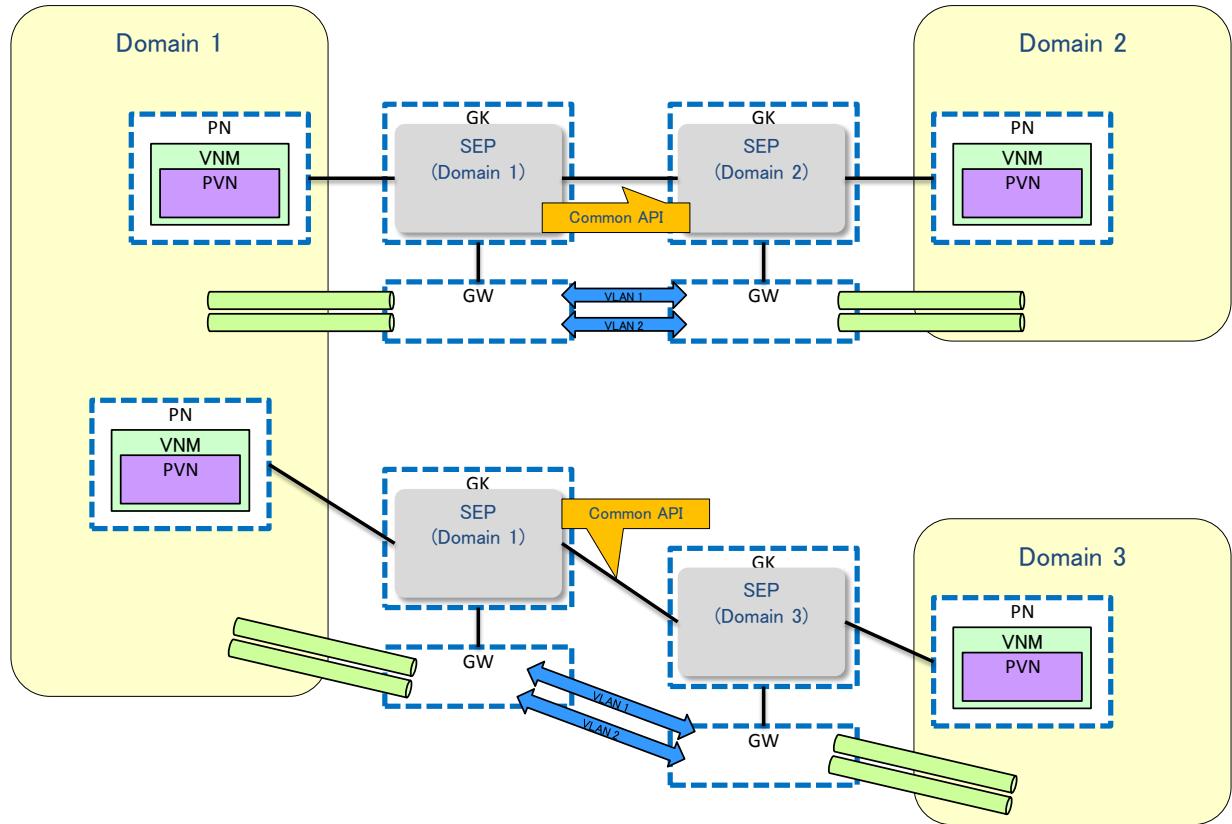


Fig. 2.2-1 Multiple domains

### 2.3 D-Plane

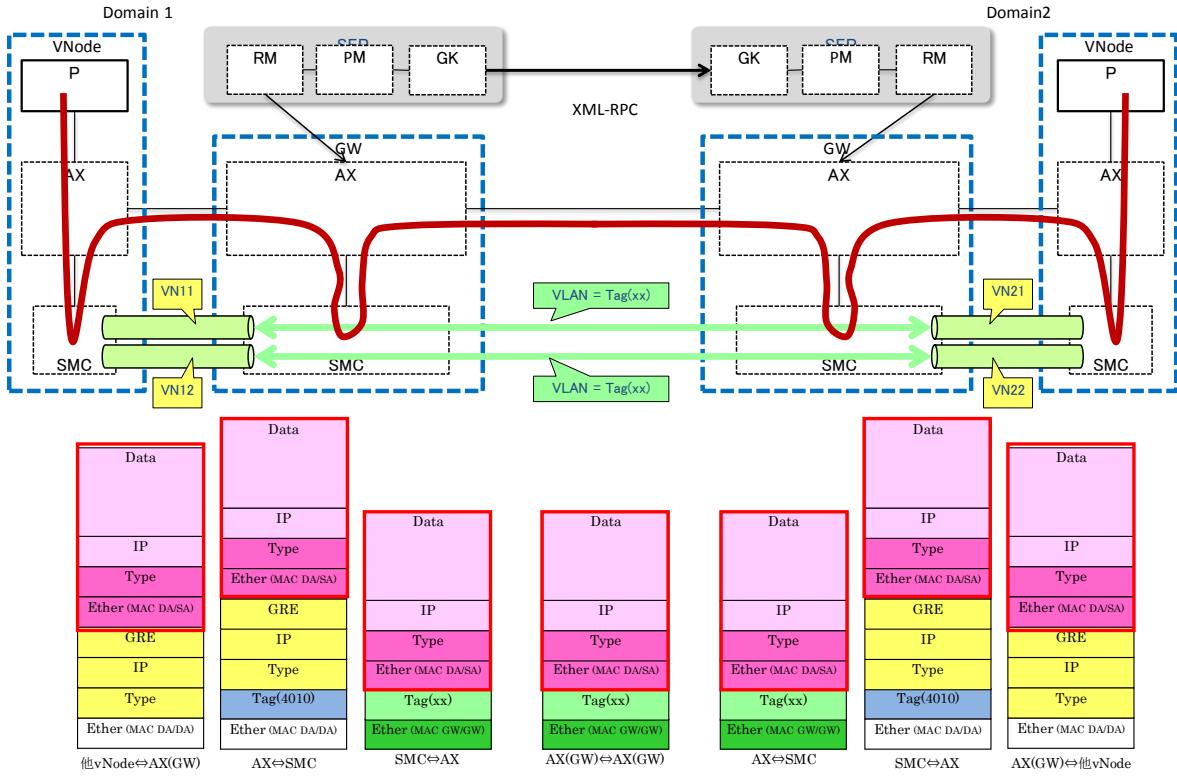


Fig. 2.3-1 D-Plane (VNode–VNode)

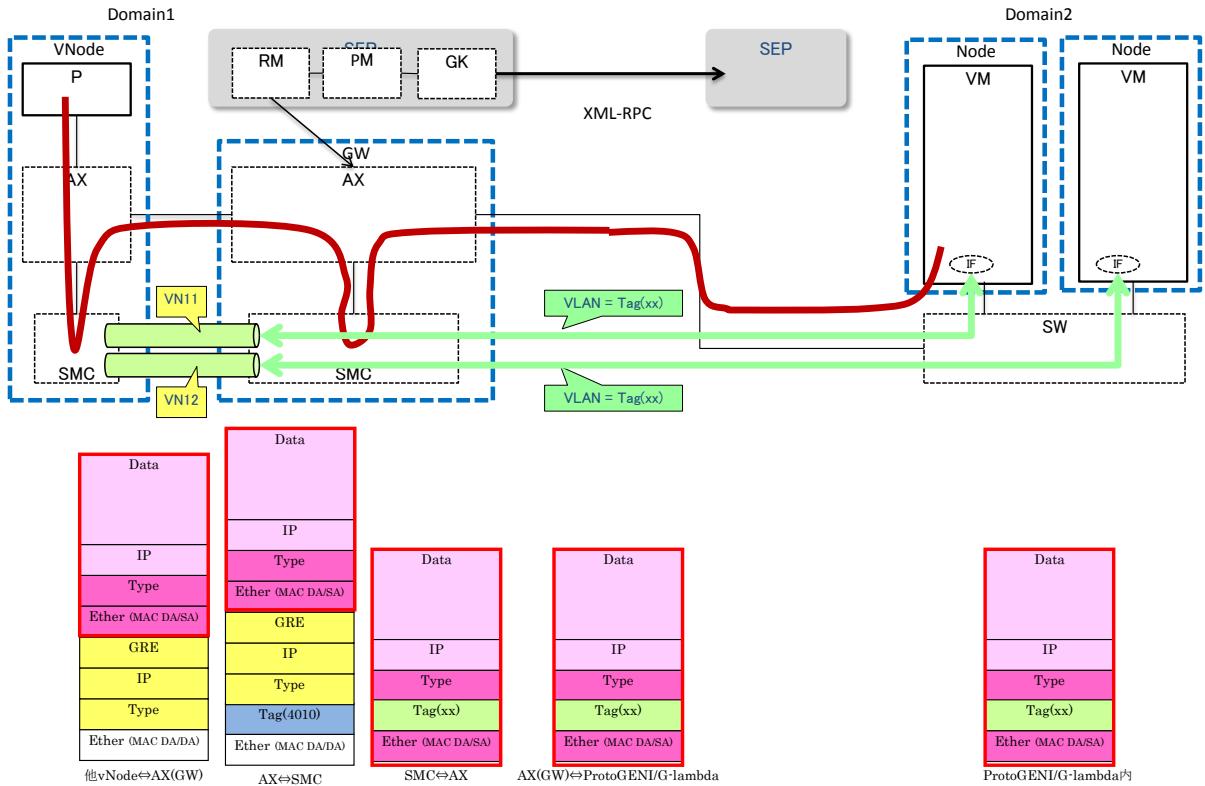


Fig. 2.3-2 D-Plane (VNode–ProtoGENI)

### 3 Common API

#### 3.1 XML-RPC

Table. 3.1-1 Common API

#	コマンド	共通 API	VN⇒PG	PG⇒VN	備考
1	Create Slice	CreateSlivers()	○	○	
2	Start Slice	RunSlivers()	○	○	
3	Stop Slice	StopSlivers()	○	○	
4	Delete Slice	DeleteSlice()	○	○	
5	Add Slivers	AddSlivers()	×	○	
6	Delete Slivers	DeleteSlivers()	×	○	
7	Get Resource Information	ResourceInfo()	×	○	
8	Get Sliver Status	SliverStatus()	○	○	
9	Get Slice Status	SliceStatus()	×	×	
10	Notify Sliver Status	SliverStatusNotify()	×	×	
11	Get Node Sliver Statistics	NodeSliverStatistics()	△	×	
12	Get Link Sliver Statistics	LinkSliverStatistics()	×	×	

凡例) VN : VNode

PG : ProtoGENI

### 3.2 Sequence

#### 3.2.1 Create Slice and Start Slice

(1) VN→PG

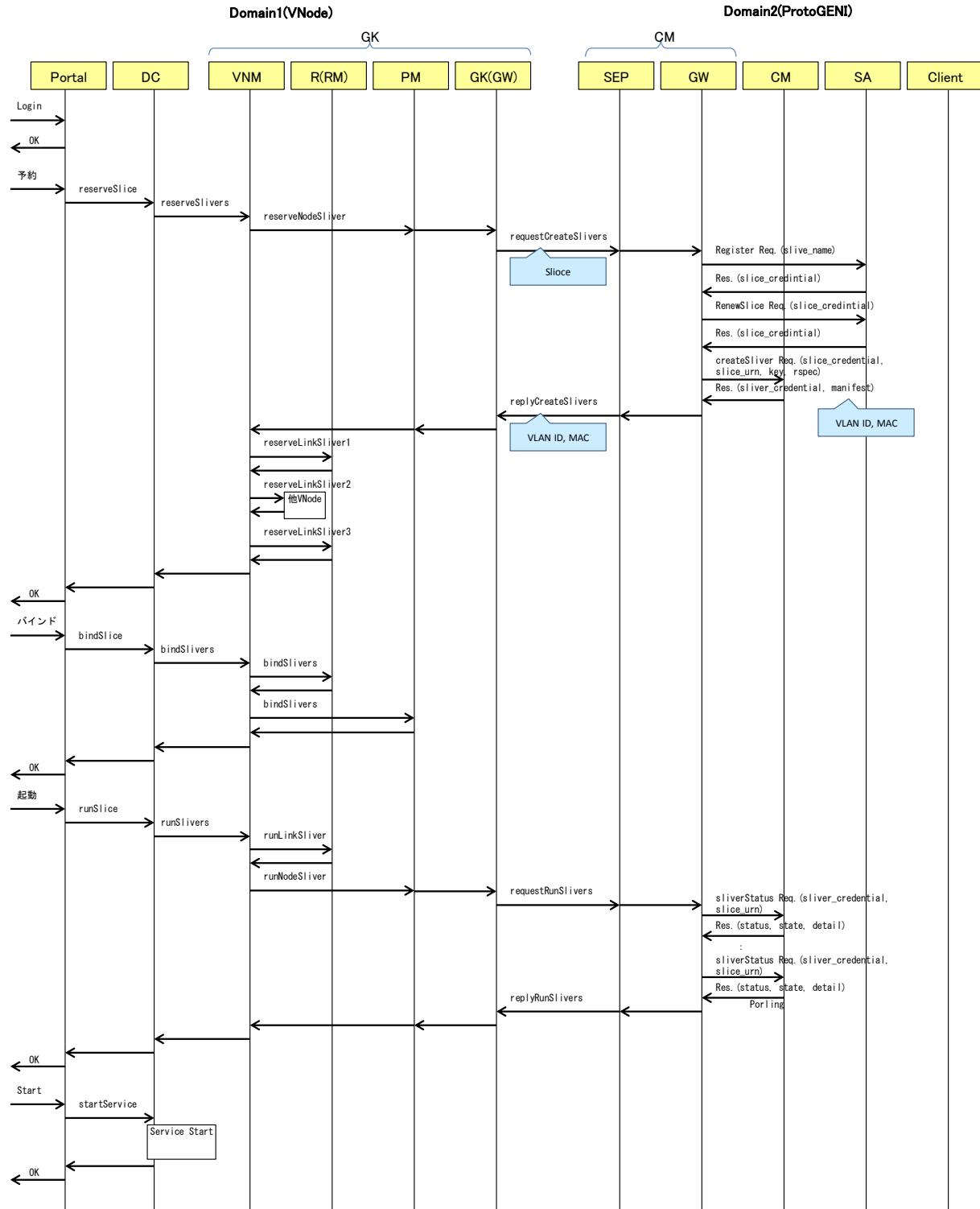


Fig. 3.2-1 Create Slice and Start Slice

(2) PG→VN

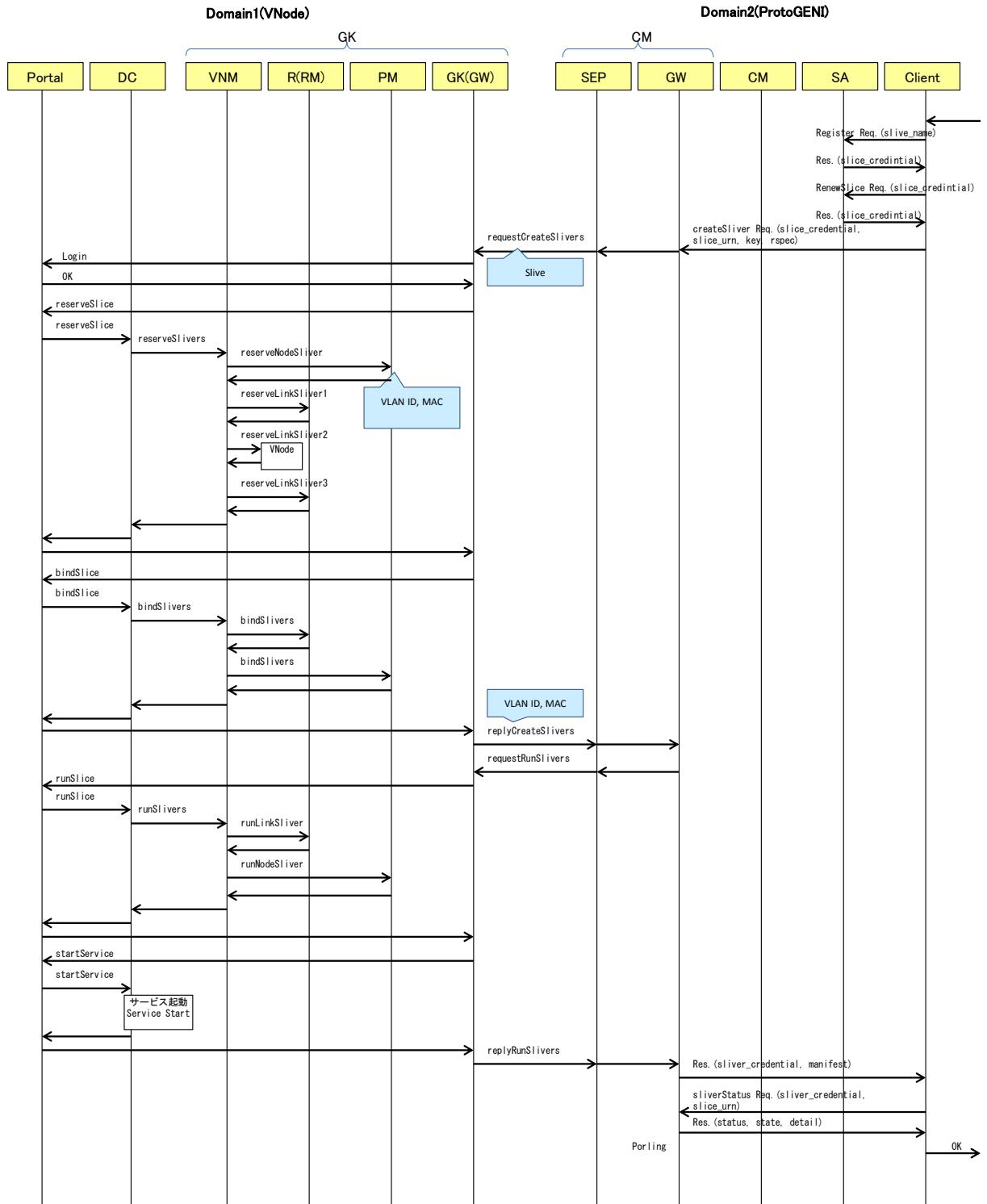


Fig. 3.2-2 Create Slice and Start Slice

### 3.2.2 Stop Slice and Delete Slice

(1)VN→PG

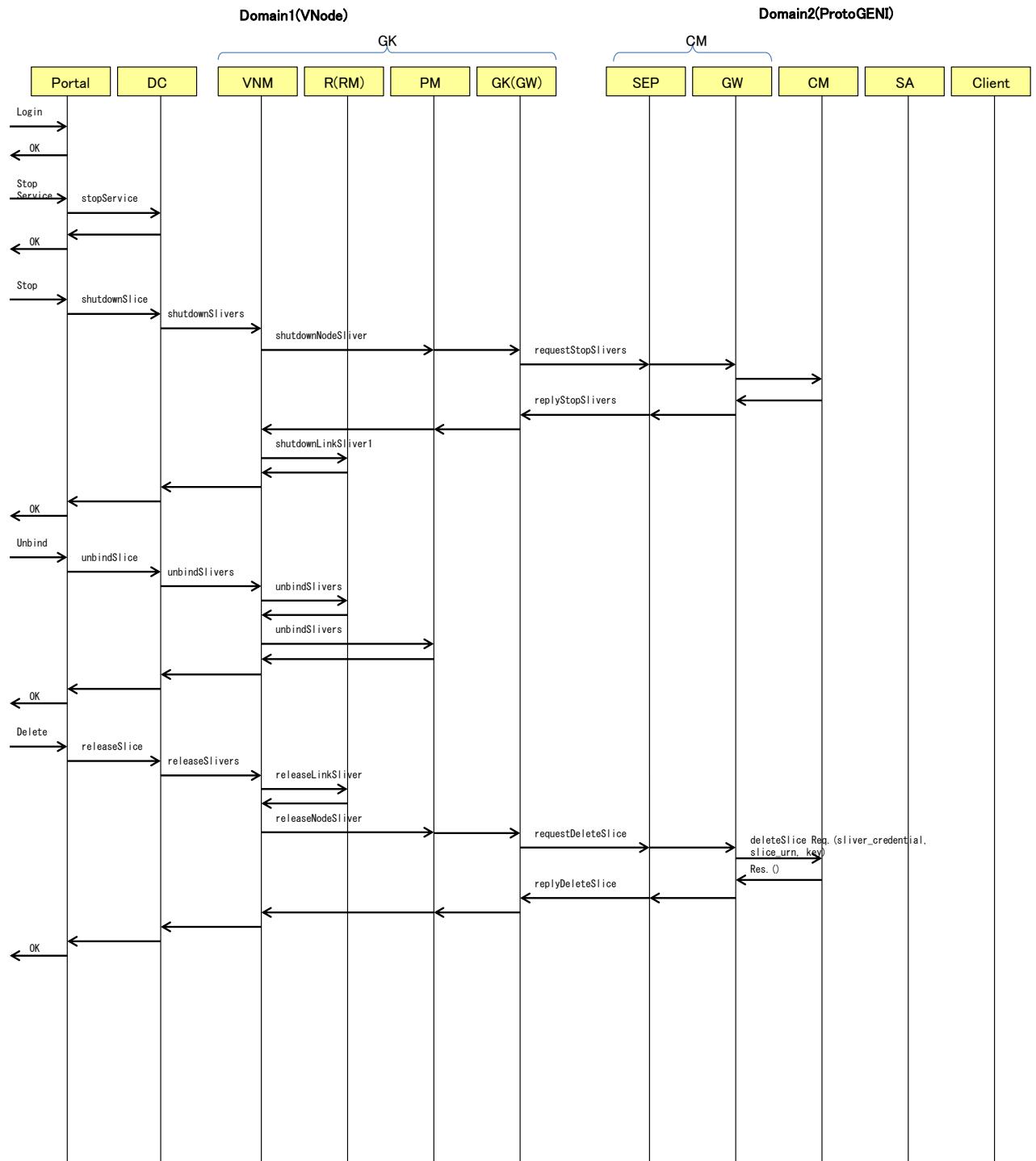


Fig. 3.2-3 Stop Slice and Delete Slice

(2) PG→VN

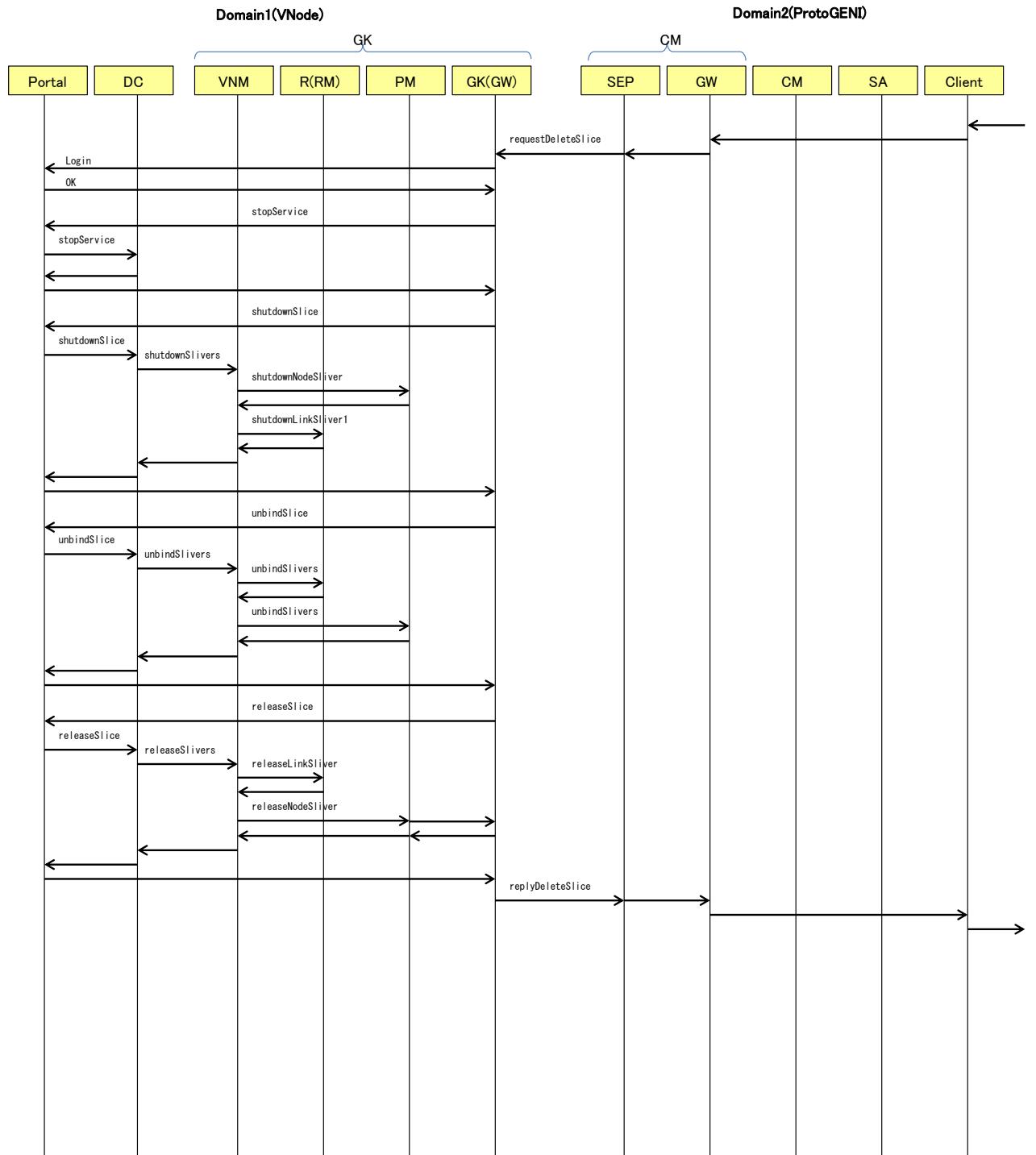


Fig. 3.2-4 Stop Slice and Delete Slice

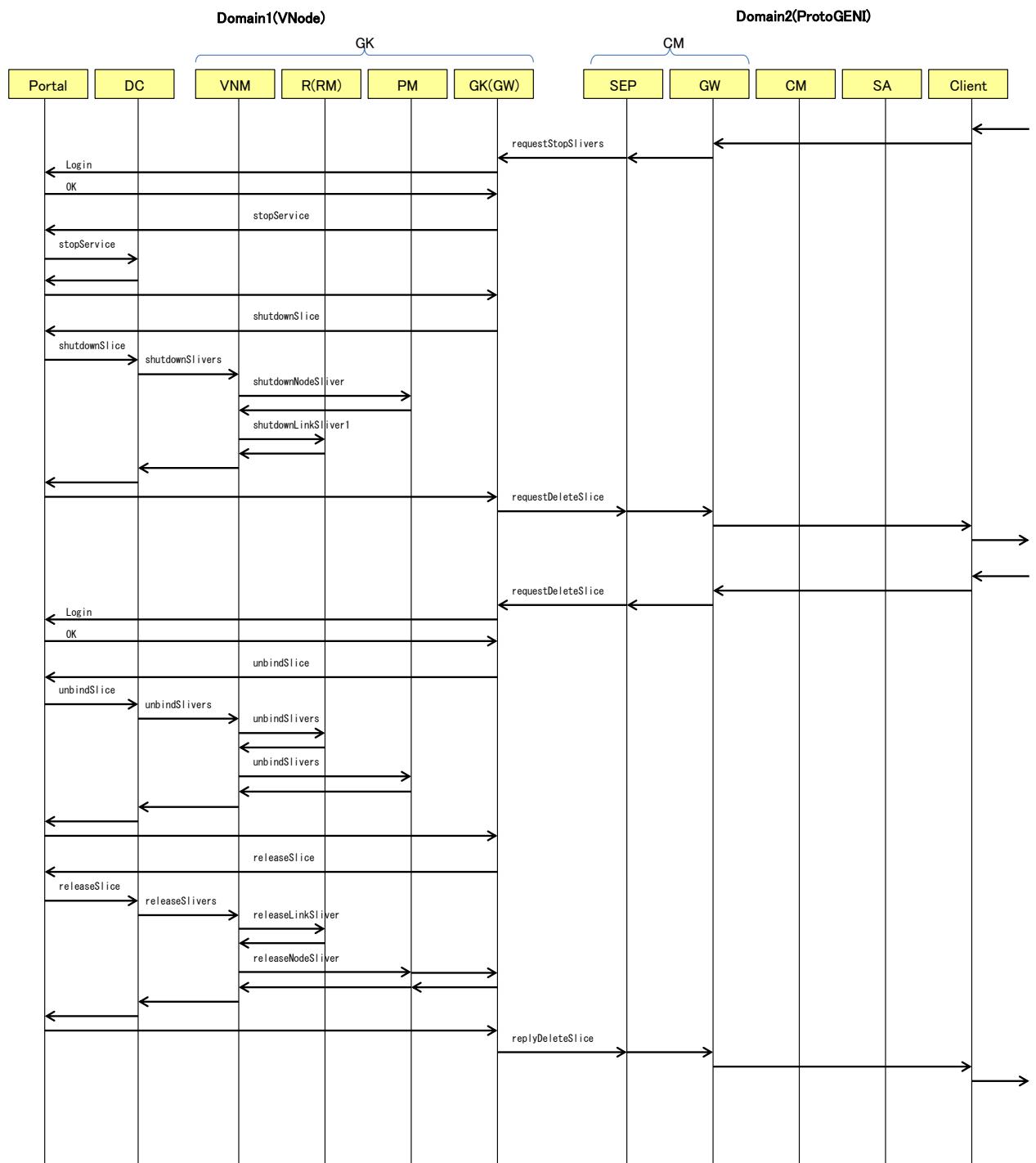


Fig. 3.2-5 Stop Slice and Delete Slice

### 3.2.3 Add Slivers

(1)VN→PG

[TBD]

(2)PG→VN

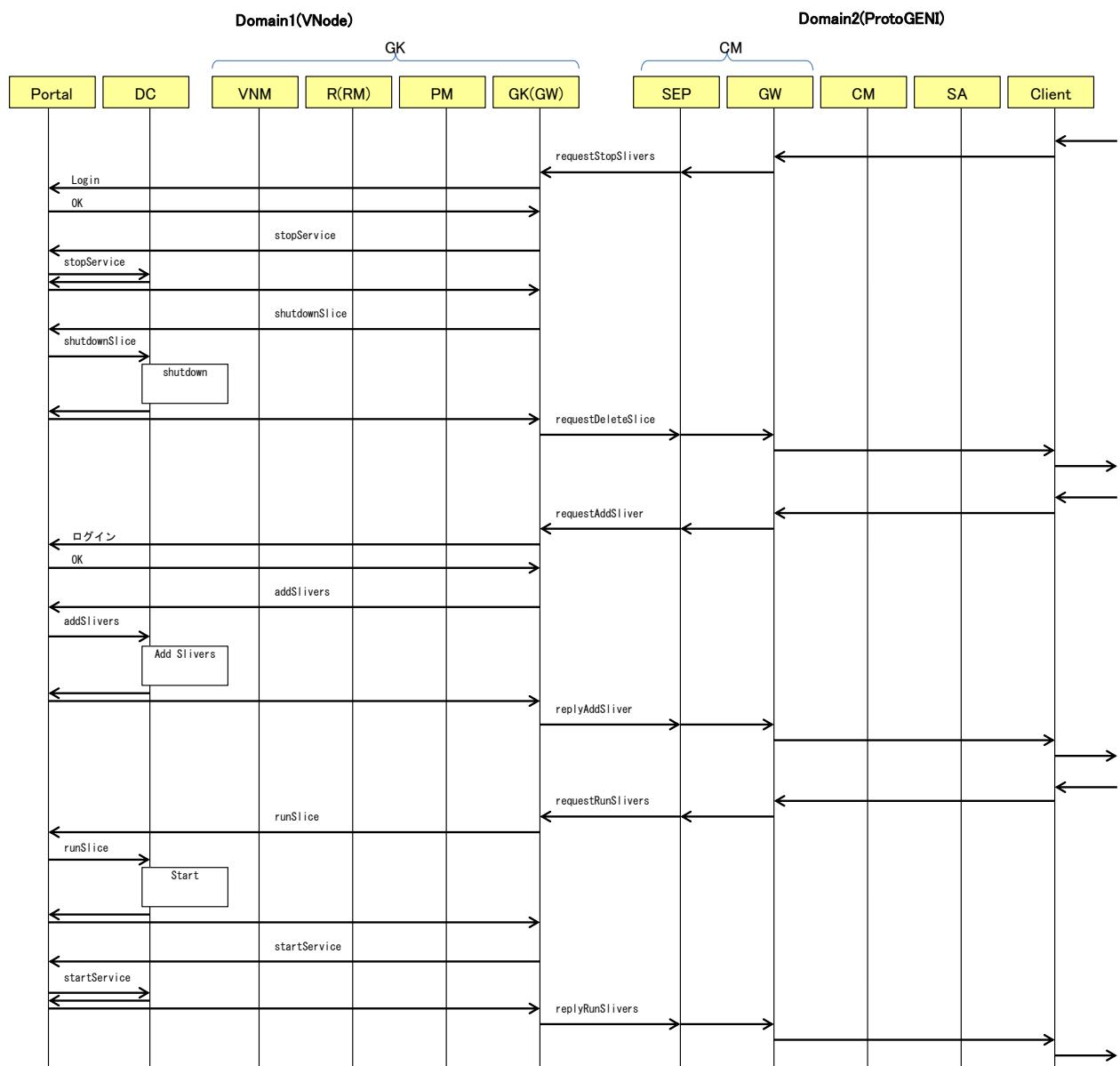


Fig. 3.2-6 Add Slivers

### 3.2.4 Delete Slivers

(1)VN→PG

[TBD]

(2)PG→VN

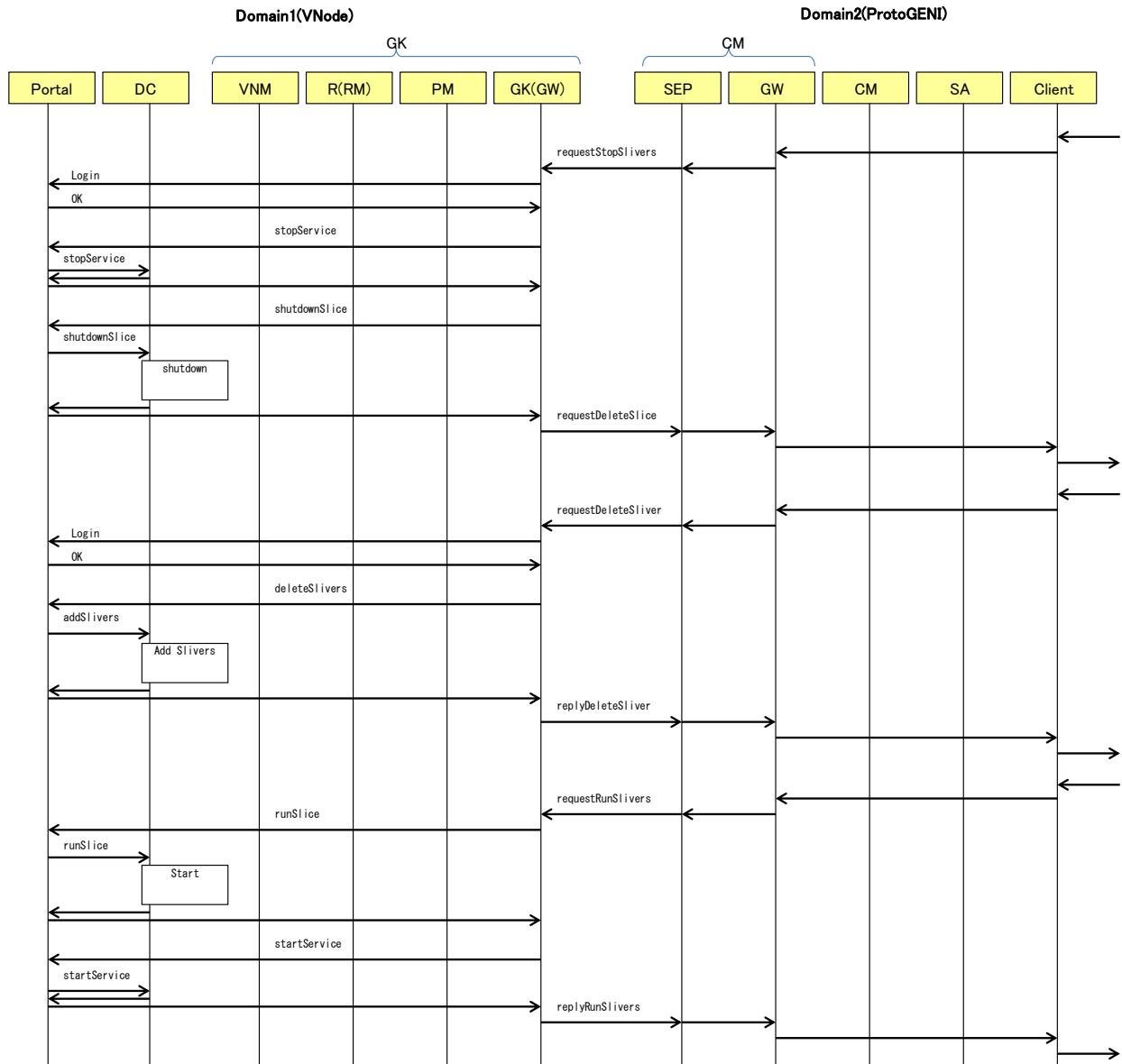


Fig. 3.2-7 Delete Slivers

### 3.2.5 Get Resource Information

(1)VN→PG

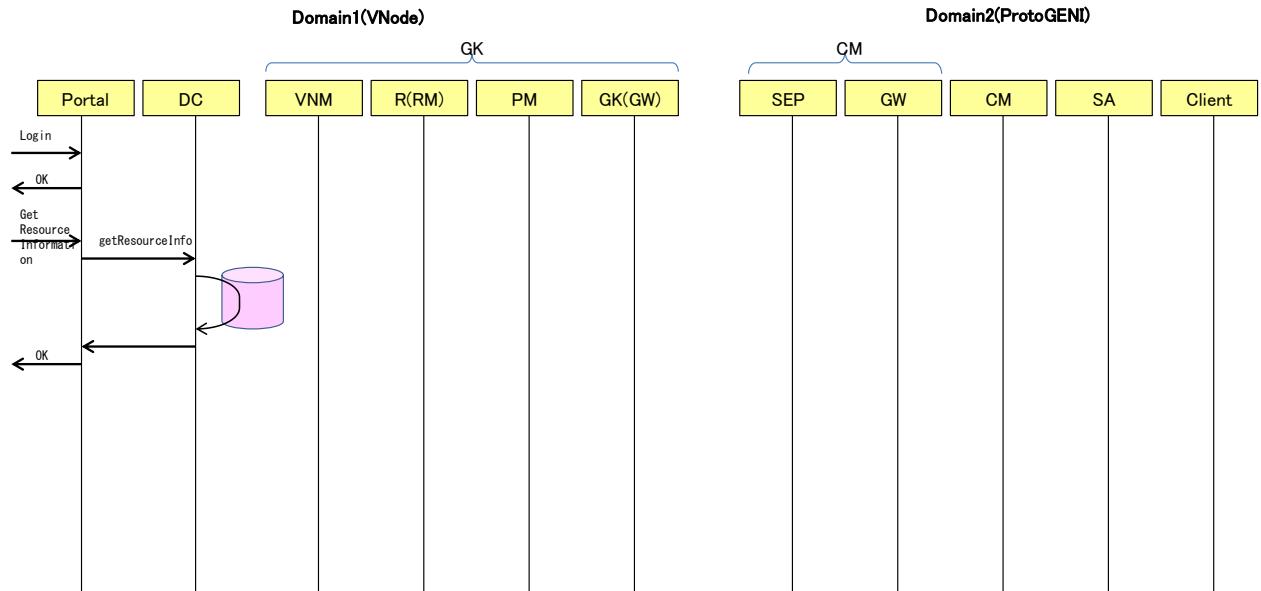


Fig. 3.2-8 Get Resource Information

(2)PG→VN

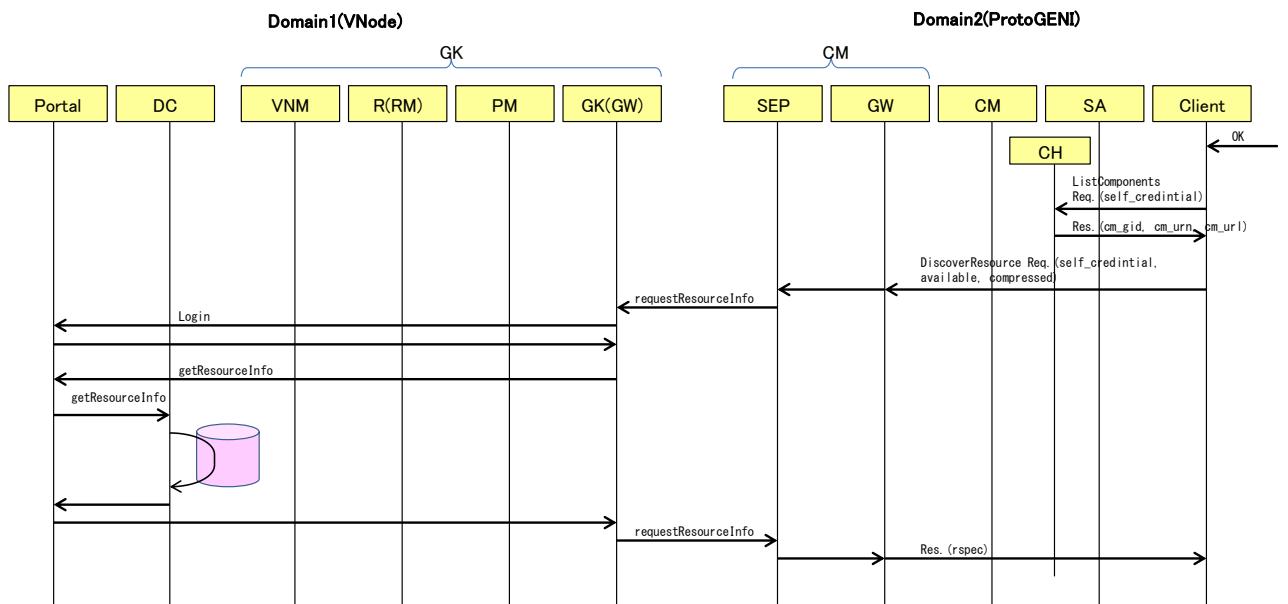


Fig. 3.2-9 Get Resource Information

### 3.2.6 Get Sliver Status

(1)VN→PG

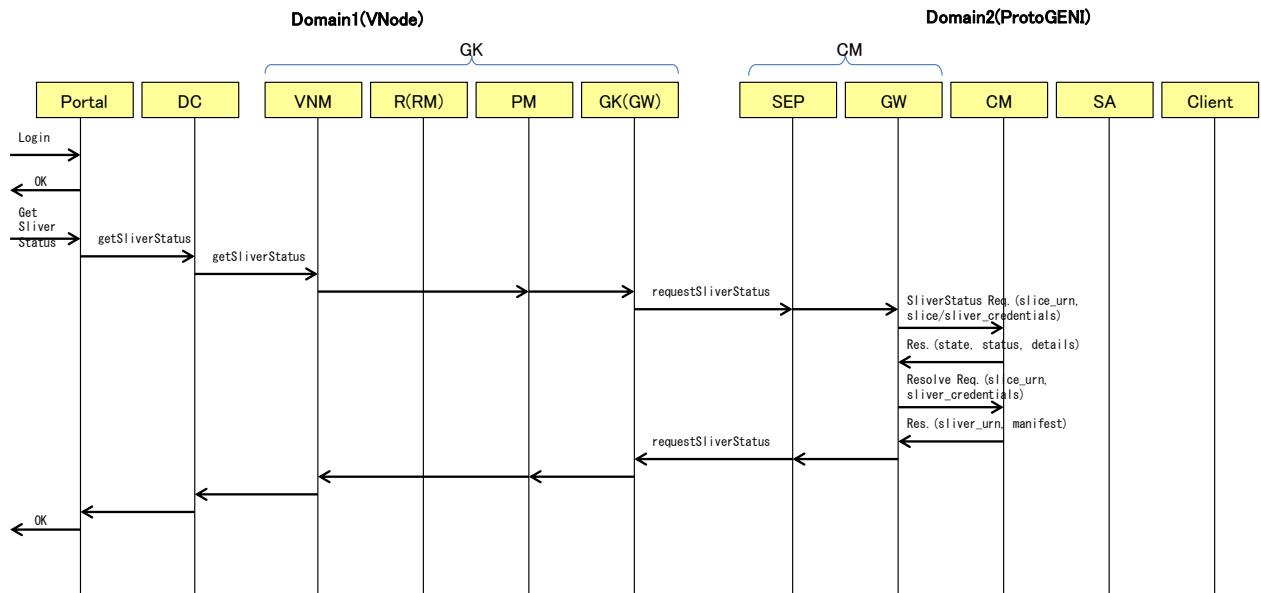


Fig. 3.2-10 Get Sliver Status

(2)PG→VN

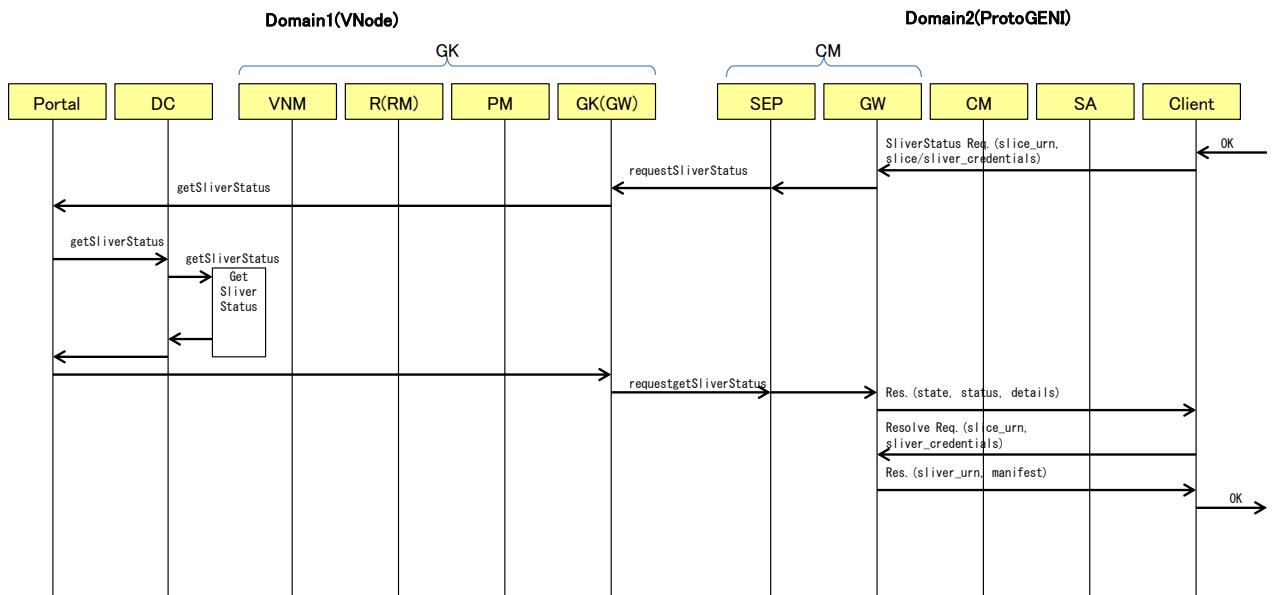


Fig. 3.2-11 Get Sliver Status

### **3.2.7 Get Slice Status**

(1)VN→PG

[TBD]

(2)PG→VN

[TBD]

### **3.2.8 Notify Sliver Status**

(1)VN→PG

[TBD]

(2)PG→VN

[TBD]

### 3.2.9 Get Node Sliver Statistics

(1)VN→PG

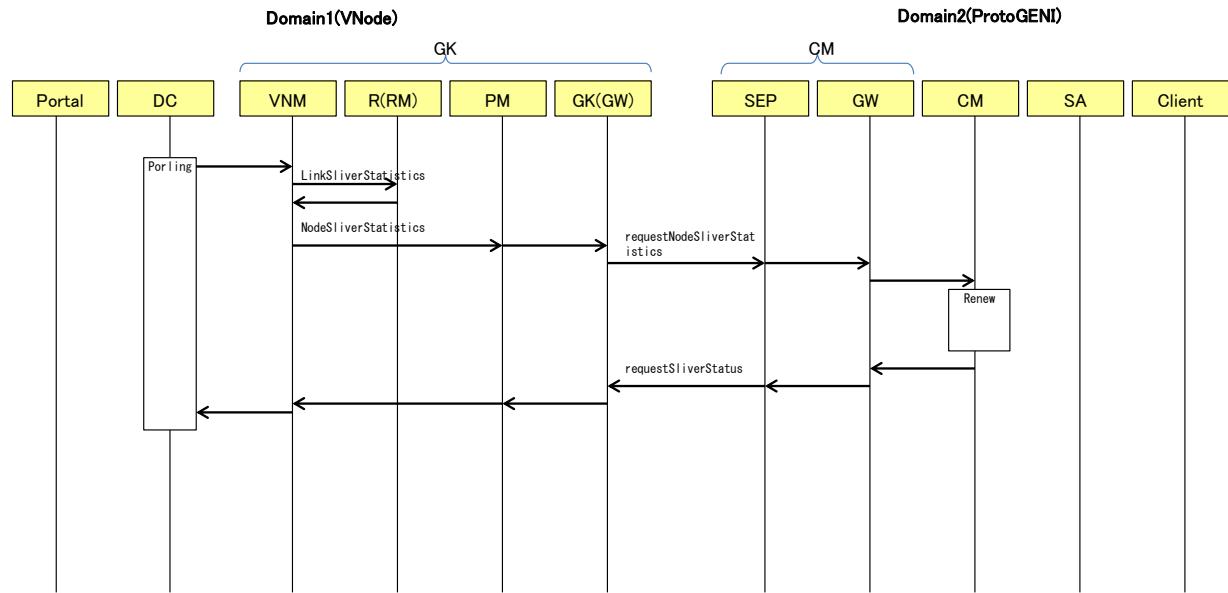


Fig. 3.2-12 Get Node Sliver Statistics

(2)PG→VN

[TBD]

### 3.2.10 Get Link Sliver Statistics

(1)VN→PG

[TBD]

(2)PG→VN

[TBD]

### 3.3 Common API Format

#### 3.3.1 CreateSlivers

methodName	param	type		request			
				VN→PG	VN→VN	PG→VN	G-LAMB DA→VN
request.CreateSlivers	[	struct	must				
	command_version	string	must	O	O	O	O
	src_infra_name	string	must	O	O	O	O
	dst_infra_name	string	must	O	O	O	O
	src_slice_id	string	must	O	O	O	O
	nodeSlivers	array	must	O	O	O	O
	nodeSliver	struct	must	O	O	O	O
	sliver_id	string	must	O	O	O	O
	sliver_name	string		X	X		
	sliver_type	string	must	O	O	O	O
	parent_sliver_id	string	must	O	O	O	O
	node_type	string		O	O	O	?
	node_subtype	string		O	O	O	?
	location_name	string		X	X	O	?
	location_country	string		X	X	O	?
	location_longitude	string		X	X	O	?
	location_latitude	string		X	X	O	?
	start_time	dateTime		O	O	O	?
	end_time	dateTime		NULL	NULL	NULL	?
	os_name	string		O	O	O	?
	os_image_path	string	must	O	O	O	O
	software_install	struct		X	X	O	?
	install_urn	string		X	X	O	?
	install_path	string		X	X	O	?
	execute_path	string		X	X	O	?
	resource	struct		O	O	X	?
	cpumode	string		O	O	X	?
	cpu	string		O	O	X	?
	arch	string		O	O	X	?
	memory	string		O	O	X	?
	interfaces	array	must	O	O	O	?
	interface	struct	must	O	O	O	?
	interface_name	string	must	O	O	O	?
	src_vlan_id	int		O	O	O	?
	dst_vlan_id	int		O	O	X	?
	src_mac_address	string		O	O	X	?
	dst_mac_address	string		O	O	X	?
	ip_address	string		X	X	O	?
	ip_netmask	string		X	X	O	?
	ip_type	string		X	X	O	?
	vlan_id	int	—	O	=	—	—
	linkSlivers	array	must	O	O	O	?

	linkSliver	struct	must	O	O	O	?
	sliver_id	string	must	O	O	O	?
	link_type	string		O	O	X	?
	link_subtype	string		O	O	X	?
	parent_sliver_id	string		O	O	X	?
	vlan_id	int		O	-		
	resource	struct		O	O	X	?
	class	string		O	O	X	?
	bandwidth	string		O	O	X	?
	burstSize	string		O	O	X	?
	queuingDelay	string		O	O	X	?
	interfaces	array		O	O	X	?
	interface	struct		O	O	X	?
	interface_name	string		O	O	X	?
	binds	array		O	O	X	X
	bind	struct		O	O	X	X
	bind_name	string		O	O	X	X
	parent_sliver_id	string		O	O	X	X
	bind_infos	array		O	O	X	X
	bind_info	struct		O	O	X	X
	sliver_name	string		O	O	X	X
	interface_name	string		O	O	X	X
	vlan_id	int		-	O		
	macaddress	string		-	O		
	infraSpec	base64		O	O	X	X
	mapping	array		O	O	X	?
	amap	struct		O	O	X	?
	sliver_id	string		O	O	X	?
	location	string		O	O	X	?
	}						
methodName	param	type		reply			
				VN→PG →I& V	VN→VN →I& V	PG→VN →P	G-LAMB DA→VN →G
reply.CreateSlivers	[	struct	must				
	command_version	string	must	O	O	O	O
	src_infra_name	string	must	O	O	O	O
	dst_infra_name	string	must	O	O	O	O
	src_slice_id	string	must	O	O	O	O
	return_code	int	must	O	O	O	O
	nodeSlivers	array	must	O	O	O	?
	nodeSliver	struct	must	O	O	O	?
	sliver_id	string	must	O	O	O	?
	sliver_name	string		-	-		
	sliver_type	string	must	O	O	O	?
	parent_sliver_id	string	must	O	O	O	?
	node_type	string		O	O	O	?
	node_subtype	string		O	O	O	?
	location_name	string		X	X	O	?
	location_country	string		X	X	O	?
	location_longitude	string		X	X	O	?
	location_latitude	string		X	X	O	?

start_time	dateTime		x	x	o	?
end_time	dateTime		x	x	o	?
os_name	string		o	o	o	?
os_image_path	string	must	o	o	o	?
software_install	struct		x	x	o	?
install_urn	string		x	x	o	?
install_path	string		x	x	o	?
execute_path	string		x	x	o	?
resource	struct		o	o	x	?
cpumode	string		o	o	x	?
cpu	string		o	o	x	?
arch	string		o	o	x	?
memory	string		o	o	x	?
interfaces	array	must	o	o	o	?
interface	struct	must	o	o	o	?
interface_name	string	must	o	o	o	?
src_vlan_id	int		o	o	o	?
dst_vlan_id	int		o	o	o	?
src_mac_address	string		o	o	x	?
dst_mac_address	string		o	o	x	?
ip_address	string		x	x	o	?
ip_netmask	string		x	x	o	?
ip_type	string		x	x	o	?
vlan_id	int		o	-		
linkSlivers	array	must	o	o	o	?
linkSliver	struct	must	o	o	o	?
sliver_id	string	must	o	o	o	?
link_type	string		o	o	x	?
link_subtype	string		o	o	x	?
parent_sliver_id	string		o	o	x	?
vlan_id	int		o	-		
resource	struct		o	o	x	?
class	string		o	o	x	?
bandwidth	string		o	o	x	?
burstSize	string		o	o	x	?
queuingDelay	string		o	o	x	?
interfaces	array		o	o	x	?
interface	struct		o	o	x	?
interface_name	string		o	o	x	?
binds	array		o	o	x	x
bind	struct		o	o	x	x
bind_name	string		o	o	x	x
parent_sliver_id	string				x	x
bind_infos	array		o	o	x	x
bind_info	struct		o	o	x	x
sliver_name	string		o	o	x	x
interface_name	string		o	o	x	x

vlan_id	int		-	O		
macaddress	string		-	O		
infraSpec	base64		O	O	x	x
mapping	array		O	O	x	?
amap	struct		O	O	x	?
sliver_id	string		O	O	x	?
location	string		O	O	x	?
}						

### 3.3.2 AddSlivers

methodName	param	type		request			
				VN→PG	VN→VN	PG→VN	G-LAMB DA→VN
request.AddSlivers	{						
	command_version	string	must	x	x	○	○
	src_infra_name	string	must	x	x	○	○
	dst_infra_name	string	must	x	x	○	○
	src_slice_id	string	must	x	x	○	○
	nodeSlivers	array	must	x	x	○	○
	nodeSliver	struct	must	x	x	○	○
	sliver_id	string	must	x	x	○	○
	sliver_type	string	must	x	x		
	parent_sliver_id	string	must	x	x	○	○
	node_type	string		x	x	○	?
	node_subtype	string		x	x	○	?
	location_name	string		x	x	○	?
	location_country	string		x	x	○	?
	location_longitude	string		x	x	○	?
	location_latitude	string		x	x	○	?
	start_time	dateTime		○	○	○	?
	end_time	dateTime		NULL	NULL	NULL	?
	os_name	string		x	x	○	?
	os_image_path	string	must	x	x	○	?
	software_install	struct		x	x	○	?
	install_urn	string		x	x	○	?
	install_path	string		x	x	○	?
	execute_path	string		x	x	○	?
	resource	struct		x	x	×	?
	cpumode	string		x	x	x	?
	cpu	string		x	x	x	?
	arch	string		x	x	x	?
	memory	string		x	x	x	?
	interfaces	array	must	x	x	○	?
	interface	struct	must	x	x	○	?
	interface_name	string	must	x	x	○	?
	src_vlan_id	string		x	x	○	?
	dst_vlan_id	string		x	x	x	?
	src_mac_address	string		x	x	x	?
	dst_mac_address	string		x	x	x	?
	ip_address	string		x	x	○	?
	ip_netmask	string		x	x	○	?
	ip_type	string		x	x	○	?
	vlan_id	int		x	x		?
	linkSlivers	array	must	x	x	○	?
	linkSliver	struct	must	x	x	○	?
	sliver_id	string	must	x	x	○	?

	link_type	string		x	x	x	?
	link_subtype	string		x	x	x	?
	parent_sliver_id	string		x	x	x	?
	vlan_id	int		x	x	x	?
	resource	struct		x	x	x	?
	class	string		x	x	x	?
	bandwidth	string		x	x	x	?
	burstSize	string		x	x	x	?
	queuingDelay	string		x	x	x	?
	interfaces	array	must	x	x	x	?
	interface	struct	must	x	x	x	?
	interface_name	string	must	x	x	x	?
	binds	array		x	x	x	?
	bind	struct		x	x	x	?
	bind_name	string		x	x	x	?
	parent_sliver_id	string		x	x	x	?
	bind_infos	array		x	x	x	x
	bind_info	struct		x	x	x	x
	sliver_name	string		x	x	x	x
	interface_name	string		x	x	x	x
	vlan_id	int		x	x	x	x
	macaddress	string		x	x	x	x
	infraSpec	base64		x	x	x	x
	mapping	array		x	x	x	?
	amap	struct		x	x	x	?
	sliver_id	string		x	x	x	?
	location	string		x	x	x	?
	}						
methodName	param	type		reply			
				VN→PG →旧V	VN→VN →旧V	PG→VN →P	G-LAMB DA→VN →G
reply.AddSlivers	{						
	command_version	string	must	O	x	O	O
	src_infra_name	string	must	O	x	O	O
	dst_infra_name	string	must	O	x	O	O
	src_slice_id	string	must	O	x	O	O
	return_code	int	must	O	x	O	O
	nodeSlivers	array	must	O	x	O	O
	nodeSliver	struct	must	O	x	O	O
	sliver_id	string	must	O	x	O	O
	sliver_type	string		O	x		
	parent_sliver_id	string	must	O	x	O	O
	node_type	string		O	x	O	?
	node_subtype	string		O	x	O	?
	location_name	string		x	x	O	?
	location_country	string		x	x	O	?
	location_longitude	string		x	x	O	?
	location_latitude	string		x	x	O	?
	start_time	dateTime		x	x	O	?
	end_time	dateTime		NULL	NULL	NULL	?
	os_name	string		O	x	O	?

os_image_path	string		○	×	○	?
software_install	struct		×	×	○	?
install_urn	string		×	×	○	?
install_path	string		×	×	○	?
execute_path	string		×	×	○	?
resource	struct		○	×	×	?
cpumode	string		○	×	×	?
cpu	string		○	×	×	?
arch	string		○	×	×	?
memory	string		○	×	×	?
interfaces	array	must	○	×	○	?
interface	struct	must	○	×	○	?
interface_name	string	must	○	×	○	?
src_vlan_id	string		○	×	○	?
dst_vlan_id	string		○	×	×	?
src_mac_address	string		○	×	×	?
dst_mac_address	string		○	×	×	?
ip_address	string		×	×	○	?
ip_netmask	string		×	×	○	?
ip_type	string		×	×	○	?
vlan_id	int			×		?
linkSlivers	array	must	○	×	○	?
linkSliver	struct	must	○	×	○	?
sliver_id	string	must	○	×	○	?
link_type	string		○	×	×	?
link_subtype	string		○	×	×	?
parent_sliver_id	string		○	×	×	?
vlan_id	int			×	×	?
resource	struct		○	×	×	?
class	string		○	×	×	?
bandwidth	string		○	×	×	?
burstSize	string		○	×	×	?
queuingDelay	string		○	×	×	?
interfaces	struct		○	×	×	?
interface	must		○	×	×	?
interface_name	string		○	×	×	?
binds	array		×	×	×	?
bind	struct		×	×	×	?
bind_name	string		×	×	×	?
parent_sliver_id	string		×	×	×	?
bind_infos	array	must	×	×	×	×
bind_info	struct		×	×	×	×
sliver_name	string		×	×	×	×
interface_name	string		×	×	×	×
vlan_id	int		×	×	×	×
macaddress	string		×	×	×	×

infraSpec	base64		x	x	x	x
mapping	array		x	x	x	?
amap	struct		x	x	x	?
sliver_id	string		x	x	x	?
location	string		x	x	x	?
}						

### 3.3.3 RunSlivers

methodName	param	type		request			
				VN→PG	VN→VN	PG→VN	G-LAMB DA→VN
request.RunSlivers	{						
	command_version	string	must	○	○	○	○
	src_infra_name	string	must	○	○	○	○
	dst_infra_name	string	must	○	○	○	○
	src_slice_id	string	must	○	○	○	○
	nodeSlivers	array	must	○	○	○	?
	nodeSliver	struct	must	○	○	○	?
	sliver_id	string	must	○	○	○	?
	linkSlivers	array	must	○	○	○	?
	linkSliver	struct	must	○	○	○	?
	sliver_id	string	must	○	○	○	?
	}						
methodName	param	type		reply			
				VN→PG →I& V	VN→VN →I& V	PG→VN →P	G-LAMB DA→VN →G
reply.RunSlivers	{						
	command_version	string	must	○	○	○	○
	src_infra_name	string	must	○	○	○	○
	dst_infra_name	string	must	○	○	○	○
	src_slice_id	string	must	○	○	○	○
	return_code	int	must	○	○	○	○
	nodeSlivers	array	must	○	○	○	○
	nodeSliver	struct	must	○	○	○	○
	sliver_id	string	must	○	○	○	○
	return_code	int	must	○	x	x	x
	linkSlivers	array	must	○	○	○	○
	linkSliver	struct	must	○	○	○	○
	sliver_id	string	must	○	○	○	○
	return_code	int	must	○	x	x	x
	}						

### 3.3.4 StopSlivers

methodName	param	type		request			
				VN→PG	VN→VN	PG→VN	G-LAMB DA→VN
<b>request.StopSlivers</b>	{						
	command_version	string	must	○	○	○	○
	src_infra_name	string	must	○	○	○	○
	dst_infra_name	string	must	○	○	○	○
	src_slice_id	string	must	○	○	○	○
	nodeSlivers	array	must	○	○	○	?
	nodeSliver	struct	must	○	○	○	?
	sliver_id	string	must	○	○	○	?
	linkSlivers	array	must	○	○	○	?
	linkSliver	struct	must	○	○	○	?
	sliver_id	string	must	○	○	○	?
	}						
methodName	param	type		reply			
				VN→PG →I& V	VN→VN →I& V	PG→VN →P	G-LAMB DA→VN →G
<b>reply.StopSlivers</b>	{						
	command_version	string	must	○	○	○	○
	src_infra_name	string	must	○	○	○	○
	dst_infra_name	string	must	○	○	○	○
	src_slice_id	string	must	○	○	○	○
	return_code	int	must	○	○	○	○
	nodeSlivers	array	must	○	○	○	○
	nodeSliver	struct	must	○	○	○	○
	sliver_id	string	must	○	○	○	○
	return_code	int	must	○	x	x	x
	linkSlivers	array	must	○	○	○	○
	linkSliver	struct	must	○	○	○	○

### 3.3.5 DeleteSlice

methodName	param	type		request			
				VN→PG	VN→VN	PG→VN	G-LAMB DA→VN
<b>request.DeleteSlice</b>	{						
	command_version	string	must	○	○	○	○
	src_infra_name	string	must	○	○	○	○
	dst_infra_name	string	must	○	○	○	○
	src_slice_id	string	must	○	○	○	○
	}						
methodName	param	type		reply			
				VN→PG →I& V	VN→VN →I& V	PG→VN →P	G-LAMB DA→VN →G
<b>reply.DeleteSlice</b>	{						
	command_version	string	must	○	○	○	○
	src_infra_name	string	must	○	○	○	○
	dst_infra_name	string	must	○	○	○	○
	src_slice_id	string	must	○	○	○	○
	return_code	int	must	○	○	○	○
	}						

### 3.3.6 DeleteSlivers

methodName	param	type		request						
				VN→PG	VN→VN	PG→VN	G-LAMB DA→VN			
<b>request.DeleteSlivers</b>	{									
	command_version	string	must	×	×	○	○			
	src_infra_name	string	must	×	×	○	○			
	dst_infra_name	string	must	×	×	○	○			
	src_slice_id	string	must	×	×	○	○			
	nodeSlivers	array	must	×	×	○	○			
	nodeSliver	struct	must	×	×	○	○			
	sliver_id	string	must	×	×	○	○			
	linkSlivers	array	must	×	×	○	○			
	linkSliver	struct	must	×	×	○	○			
	sliver_id	string	must	×	×	○	○			
	}									
<b>methodName</b>	param	type		reply						
				VN→PG →ID V	VN→VN →ID V	PG→VN →P	G-LAMB DA→VN →G			
<b>reply.DeleteSlivers</b>				{						
				command_version	string	must	×			
				src_infra_name	string	must	×			
				dst_infra_name	string	must	×			
				src_slice_id	string	must	×			
				return_code	int	must	×			
				nodeSlivers	array	must	×			
				nodeSliver	struct	must	×			
				sliver_id	string	must	×			
				return_code	int	must	×			
				linkSlivers	array	must	×			
				linkSliver	struct	must	×			
				sliver_id	string	must	×			
				return_code	int	must	×			
				}						

### 3.3.7 ResourcesInfo

methodName	param	type		request			
				VN→PG	VN→VN	PG→VN	G-LAMB DA→VN
request.ResourcesInfo	{						
	command_version	string	must	×	×	○	○
	src_infra_name	string	must	×	×	○	○
	dst_infra_name	string	must	×	×	○	○
	src_slice_id	string	must	×	×	○	○
	nodeSlivers	array		×	×	×	×
	nodeSliver	struct		×	×	×	×
	sliver_id	string		×	×	×	×
	linkSlivers	array		×	×	×	×
	linkSliver	struct		×	×	×	×
	sliver_id	string		×	×	×	×
	}						
methodName	param	type		reply			
				VN→PG →ID V	VN→VN →ID V	PG→VN →P	G-LAMB DA→VN →G
reply.ResourcesInfo	{						
	command_version	string	must	×	×	○	○
	src_infra_name	string	must	×	×	○	○
	dst_infra_name	string	must	×	×	○	○
	src_slice_id	string	must	×	×	○	○
	return_code	int	must	×	×	○	○
	nodeSlivers	array	must	×	※1	×	?
	nodeSliver	struct	must	×	※1	×	?
	sliver_id	string	must	×	※1	×	?
	sliver_name	string		×	※1	×	?
	available	boolean	must	×	※1	×	?
	node_type	string	must	×	※1	×	?
	localtion_name	string		×	※1	×	?
	localtion_country	string		×	※1	×	?
	location_longitude	string		×	※1	×	?
	location_latitude	string		×	※1	×	?
	exclusive	bool		×	※1	×	?
	start_time	dateTime		×	※1	×	?
	end_time	dateTime		×	※1	×	?
	os_name	string		×	※1	×	?
	os_image_path	string		×	※1	×	?
	interfaces	array	must	×	※1	×	?
	interface	struct	must	×	※1	×	?
	interface_name	string	must	×	※1	×	?
	linkSlivers	array	must	×	※1	×	?
	linkSliver	struct	must	×	※1	×	?
	sliver_id	string	must	×	※1	×	?
	sliver_name	string		×	※1	×	?
	souce_id	string	must	×	※1	×	?
	souce_interface	string	must	×	※1	×	?
	dest_id	string	must	×	※1	×	?

	dest_interface	string	must	x *1	x *1	?	?
	bandwidth	string		x *1	x *1	?	?
	packet_size	int		x *1	x *1	?	?
	latency	string		x *1	x *1	?	?
	packet_loss	string		x *1	x *1	?	?
	class	string		x *1	x *1	?	?
	}						

### 3.3.8 SliverStatus

methodName	param	type		request			
				VN→PG	VN→VN	PG→VN	G-LAMB DA→VN
<b>request.SliverStatus</b>	{						
	command_version	string	must	○	○	○	○
	src_infra_name	string	must	○	○	○	○
	dst_infra_name	string	must	○	○	○	○
	src_slice_id	string	must	○	○	○	○
	nodeSlivers	array	must	○	○	○	○
	nodeSliver	struct	must	○	○	○	○
	sliver_id	string	must	○	○	○	○
	linkSlivers	array	must	○	○	○	○
	linkSliver	struct	must	○	○	○	○
	sliver_id	string	must	○	○		
	}						
methodName	param	type		reply			
				VN→PG →I& V	VN→VN →I& V	PG→VN →P	G-LAMB DA→VN →G
<b>reply.SliverStatus</b>	{						
	command_version	string	must	○	○	○	○
	src_infra_name	string	must	○	○	○	○
	dst_infra_name	string	must	○	○	○	○
	src_slice_id	string	must	○	○	○	○
	return_code	int	must	○	○	○	○
	nodeSlivers	array		○	○	○	○
	nodeSliver	struct	must	○	○	○	○
	sliver_id	string	must	○	○	○	○
	sliver_status	string		○	○	○	○
	interfaces	array	must	○	○	○	○
	interface	struct	must	○	○	○	○
	interface_name	string	must	○	○	○	○
	interface_status	string	must	○	○	○	○
	linkSlivers	array	must	○	○	○	○
	linkSliver	struct	must	○	○	○	○
	sliver_id	string	must	○	○		
	sliver_status	string	must		○		
	}						

### 3.3.9 SliceStatus

methodName	param	type		request			
				VN→PG	VN→VN	PG→VN	G-LAMB DA→VN
<b>request.SliceStatus</b>	{						
	command_version	string	must	×	×	×	×
	src_infra_name	string	must	×	×	×	×
	dst_infra_name	string	must	×	×	×	×
	src_slice_id	string	must	×	×	×	×
	}						
methodName	param	type		reply			
				VN→PG →I& V	VN→VN →I& V	PG→VN →P	G-LAMB DA→VN →G
<b>reply.SliceStatus</b>	{						
	command_version	string	must	×	×	×	×
	src_infra_name	string	must	×	×	×	×
	dst_infra_name	string	must	×	×	×	×
	src_slice_id	string	must	×	×	×	×
	return_code	int	must	×	×	×	×
	nodeSlivers	array	must	×	×	×	×
	nodeSliver	struct	must	×	×	×	×
	sliver_id	string	must	×	×	×	×
	sliver_status	string		×	×	×	×
	interfaces	array	must	×	×	×	×
	interface	struct	must	×	×	×	×
	interface_name	string		×	×	×	×
	interface_status	string	must	×	×	×	×
	linkSlivers	array	must	×	×	×	×
	linkSliver	struct	must	×	×	×	×
	sliver_id	string	must	×	×	×	×
	sliver_status	string	must	×	×	×	×
	}						

### 3.3.10 NodeSliverStatistics

methodName	param	type		request			
				VN→PG	VN→VN	PG→VN	G-LAMB DA→VN
<b>request.NodeSliverStatistics</b>	{						
	command_version	string	must	O	O	O	O
	src_infra_name	string	must	O	O	O	O
	dst_infra_name	string	must	O	O	O	O
	src_slice_id	string	must	O	O	O	O
	nodeSlivers	array	must	O	O	O	O
	nodeSliver	struct	must	O	O	O	O
	sliver_id	string	must	O	O	O	O
	}						
<b>methodName</b>	param	type		reply			
				VN→PG →旧 V	VN→VN →旧 V	PG→VN →P	G-LAMB DA→VN →G
<b>reply.NodeSliverStatistics</b>	{						
	command_version	string	must	O	O	O	O
	src_infra_name	string	must	O	O	O	O
	dst_infra_name	string	must	O	O	O	O
	src_slice_id	string	must	O	O	O	O
	return_code	int	must	O	O	O	O
	nodeSlivers	array	must	O	O	O	O
	nodeSliver	struct	must	O	O	O	O
	sliver_id	string	must	O	O	O	O
	timestamp	dateTime		X	X	X	X
	cpu	int		X	X	X	X
	memory	int		X	X	X	X
	storage	int		X	X	X	X
	interfaces	array		X	X	X	X
	interface	struct		X	X	X	X
	interface_name	string		X	X	X	X
	tx_packets	int		X	X	X	X
	rx_packets	int		X	X	X	X
	tx_bytes	int		X	X	X	X
	rx_bytes	int		X	X	X	X
	}						

### 3.3.11 LinkSliverStatistics

methodName	param	type		request			
				VN→PG	VN→VN	PG→VN	G-LAMB DA→VN
<b>request.LinkSliverStatistics</b>	{						
	command_version	string	must	×	×	×	×
	src_infra_name	string	must	×	×	×	×
	dst_infra_name	string	must	×	×	×	×
	src_slice_id	string	must	×	×	×	×
	linkSlivers	array	must	×	×	×	×
	linkSliver	struct	must	×	×	×	×
	sliver_id	string	must	×	×	×	×
	}						
methodName	param	type		reply			
				VN→PG →旧 V	VN→VN →旧 V	PG→VN →P	G-LAMB DA→VN →G
<b>reply.LinkSliverStatistics</b>	{						
	command_version	string	must	×	×	×	×
	src_infra_name	string	must	×	×	×	×
	dst_infra_name	string	must	×	×	×	×
	src_slice_id	string	must	×	×	×	×
	return_code	int	must	×	×	×	×
	linkSlivers	array	must	×	×	×	×
	linkSliver	struct	must	×	×	×	×
	sliver_id	string	must	×	×	×	×
	timestamp	dateTime		×	×	×	×
	tx_packets	int		×	×	×	×
	rx_packets	int		×	×	×	×
	tx_bytes	int		×	×	×	×
	rx_bytes	int		×	×	×	×
	latency	string		×	×	×	×
	packet_loss	string		×	×	×	×
	}						

## 4 Sample

### 4.1 Create VNode-ProtoGENI federated slice 1

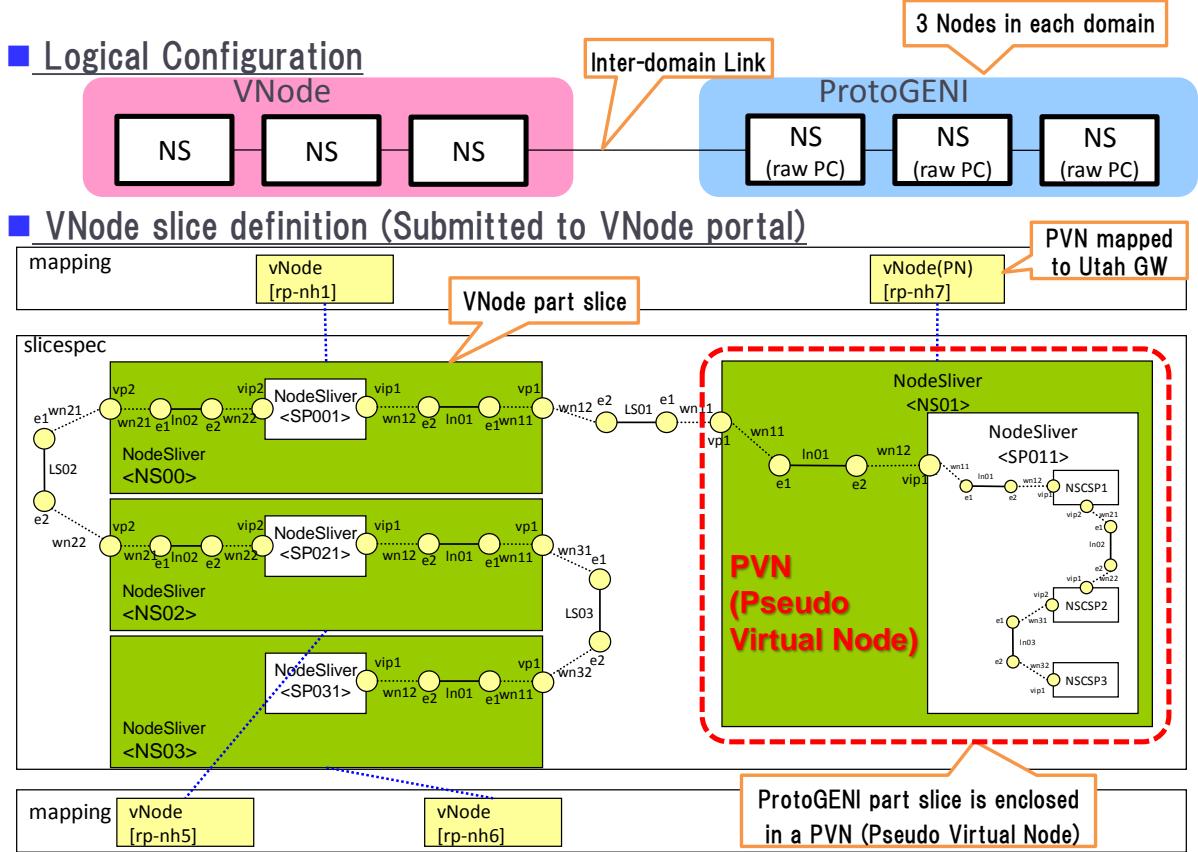
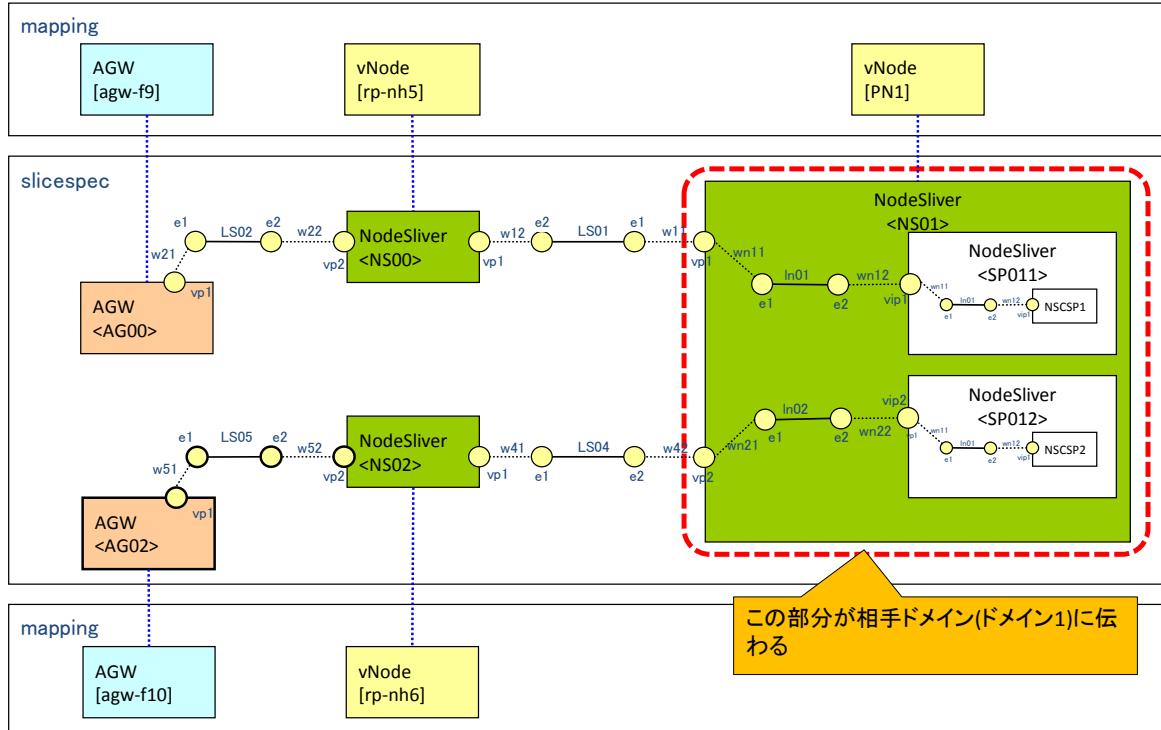


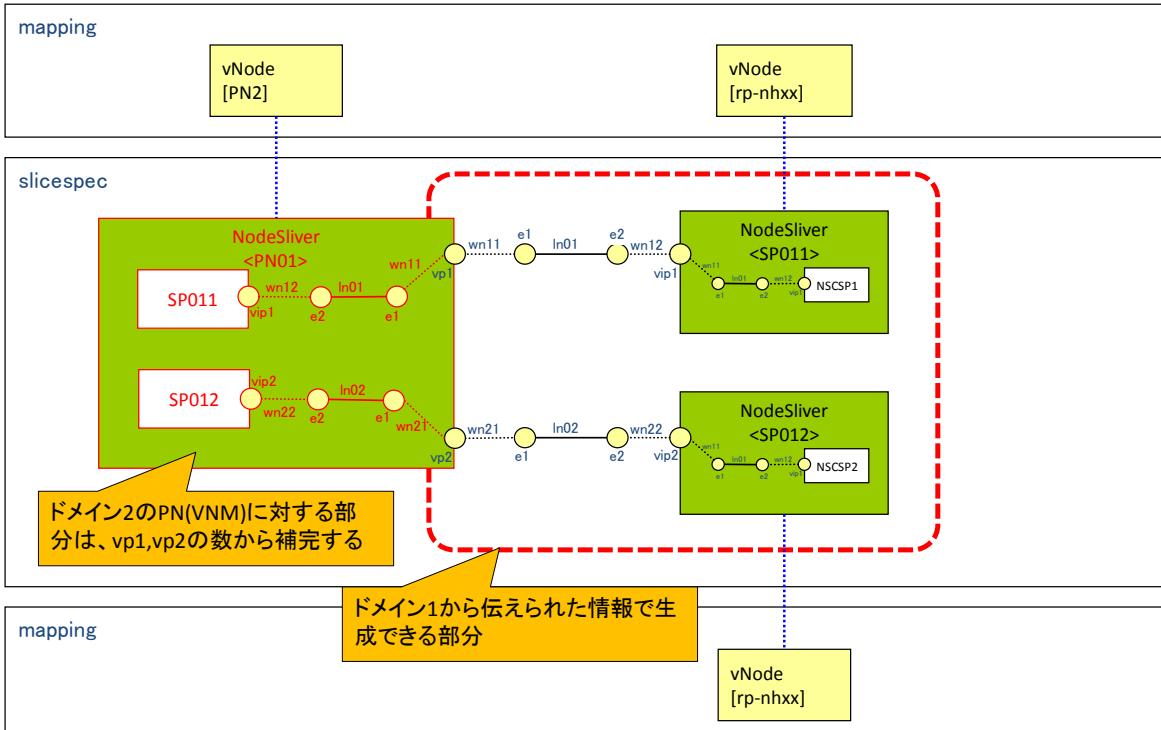
Fig. 4.1-1 Create VNode-ProtoGENI federated slice

## 4.2 Create VNode-ProtoGENI federated slice 2

(1)VNode side



(2)ProtoGENI side



### 4.3 Slice convert (VNode-VNode)

-	Domain 1 (VNode)	Domain 2 (VNode)
LinkSliver Domain 1 LS	<pre>&lt;?xml version="1.0" encoding="UTF-8"?&gt; &lt;slice-design&gt;   &lt;slicespec name="NICT_Slice_ST002"&gt;     &lt;sliverdef&gt;       &lt;linkSlivers&gt;         &lt;!-- LinkSliver LS01 --&gt;         &lt;linkSliver name="LS01" type="link" subtype="GRE"&gt;           &lt;resources&gt;             &lt;resource key="bandwidth" value="100M" /&gt;             &lt;resource key="burstSize" value="1024" /&gt;             &lt;resource key="performanceIsolation" value="policing" /&gt;           &lt;/resources&gt;           &lt;vports&gt;             &lt;vport name="e1"/&gt;             &lt;vport name="e2"/&gt;           &lt;/vports&gt;         &lt;/linkSliver&gt;         &lt;!-- LinkSliver LS02 --&gt;         &lt;linkSliver name="LS02" type="link" subtype="GRE"&gt;           &lt;resources from="e1" to="e2" &gt;             &lt;resource key="bandwidth" value="100M" /&gt;             &lt;resource key="burstSize" value="1024" /&gt;             &lt;resource key="performanceIsolation" value="policing" /&gt;           &lt;/resources&gt;           &lt;resources from="e2" to="e1" &gt;             &lt;resource key="bandwidth" value="1000K" /&gt;             &lt;resource key="burstSize" value="1024" /&gt;             &lt;resource key="performanceIsolation" value="policing" /&gt;           &lt;/resources&gt;           &lt;vports&gt;             &lt;vport name="e1"/&gt;             &lt;vport name="e2"/&gt;           &lt;/vports&gt;         &lt;/linkSliver&gt;         &lt;!-- LinkSliver LS04 --&gt;         &lt;linkSliver name="LS04" type="link" subtype="GRE"&gt;           &lt;resources&gt;             &lt;resource key="bandwidth" value="50M" /&gt;             &lt;resource key="performanceIsolation" value="policing" /&gt;           &lt;/resources&gt;           &lt;vports&gt;             &lt;vport name="e1"/&gt;             &lt;vport name="e2"/&gt;           &lt;/vports&gt;         &lt;/linkSliver&gt;         &lt;!-- LinkSliver LS05 --&gt;         &lt;linkSliver name="LS05" type="link" subtype="GRE"&gt;           &lt;resources&gt;             &lt;resource key="bandwidth" value="50M" /&gt;             &lt;resource key="performanceIsolation" value="policing" /&gt;           &lt;/resources&gt;           &lt;vports&gt;             &lt;vport name="e1"/&gt;             &lt;vport name="e2"/&gt;           &lt;/vports&gt;         &lt;/linkSliver&gt;       &lt;/linkSlivers&gt;     &lt;/sliverdef&gt;   &lt;/slicespec&gt; &lt;/slice-design&gt;</pre>	<pre>&lt;?xml version="1.0" encoding="UTF-8"?&gt; &lt;slice-design&gt;   &lt;slicespec name="Federation_Slice_NS01"&gt;     &lt;sliverdef&gt;       &lt;linkSlivers&gt;         &lt;linkSliver name="In01" type="link"&gt;           &lt;vports&gt;             &lt;vport name="e1" /&gt;             &lt;vport name="e2" /&gt;           &lt;/vports&gt;         &lt;/linkSliver&gt;         &lt;linkSliver name="In02" type="link"&gt;           &lt;vports&gt;             &lt;vport name="e1" /&gt;             &lt;vport name="e2" /&gt;           &lt;/vports&gt;         &lt;/linkSliver&gt;         &lt;linkSliver name="In03" type="link"&gt;           &lt;vports&gt;             &lt;vport name="e1" /&gt;             &lt;vport name="e2" /&gt;           &lt;/vports&gt;         &lt;/linkSliver&gt;       &lt;/linkSlivers&gt;     &lt;/sliverdef&gt;   &lt;/slicespec&gt; &lt;/slice-design&gt;</pre>
Domain 1 LS		
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NSC (Node Sliver Component)		
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NSC (Node Component)	<pre> &lt;hierarchy&gt;   &lt;sliverdef&gt;     &lt;nodeSlivers&gt;       &lt;nodeSliver name="SP02"&gt;         &lt;vports&gt;           &lt;vport name="vip1" /&gt;           &lt;vport name="vip2" /&gt;         &lt;/vports&gt;       &lt;instance type="SlowPath_VM" subtype="KVM"&gt;         &lt;resources&gt;           &lt;resource key="cpumode" value="dedicated" /&gt;           &lt;resource key="cpu" value="1" /&gt;           &lt;resource key="arch" value="x86_64" /&gt;           &lt;resource key="memory" value="2048" /&gt;         &lt;/resources&gt;         &lt;params&gt;           &lt;param value="http://192.168.50.58/nict-test/sp/KVM_Ubuntu1010Server32.img" /&gt;         &lt;/params&gt;       &lt;/instance&gt;     &lt;/nodeSliver&gt;   &lt;/nodeSlivers&gt; </pre>	<pre> &lt;hierarchy&gt;   &lt;sliverdef&gt;     &lt;nodeSlivers&gt;       &lt;nodeSliver name="SP011"&gt;         &lt;vports&gt;           &lt;vport name="vip1" /&gt;         &lt;/vports&gt;       &lt;instance type="SlowPath_VM" subtype="KVM"&gt;         &lt;resources&gt;           &lt;resource key="cpumode" value="dedicated" /&gt;           &lt;resource key="cpu" value="1" /&gt;           &lt;resource key="arch" value="x86_64" /&gt;           &lt;resource key="memory" value="2048" /&gt;         &lt;/resources&gt;         &lt;params&gt;           &lt;param value="http://192.168.50.58/nict-test/sp/KVM_Ubuntu1010Server32.img" /&gt;         &lt;/params&gt;       &lt;/instance&gt;     &lt;/nodeSliver&gt;   &lt;/nodeSlivers&gt; </pre>
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Physics mapping		