Exploring the virtual infrastructure service concept in Grid'5000

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INSTITUT NATIONAL DE RECHERCHE EN INFORMATIQUE ET EN AUTOMATIQUE

INRIA

RESO

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Context: Virtualized Infrastructures

- Virtualized Infrastructure is a concept emerging from Virtual Networks, Virtualization and Infrastructure as a Service waves
- Currently, there are many projects/users seeking a private and customized infrastructure utilization
- Eg. Computer science researchers need access to customized scalable testbeds where they can run reproducible experiments

Key issue:

network performance control in virtualized infrastructures

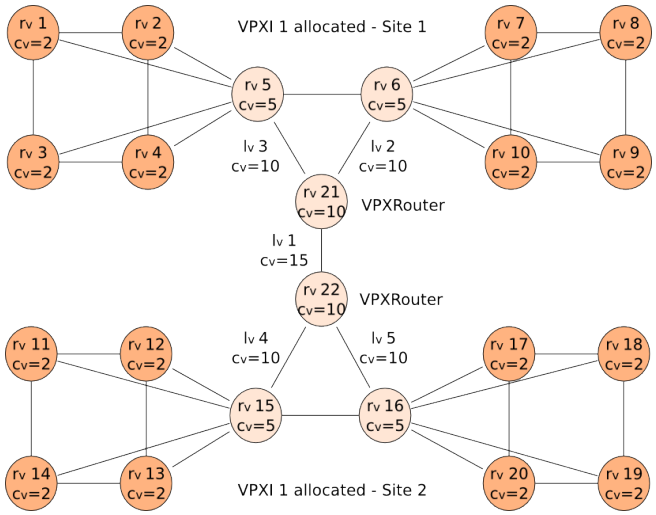
Key points of our proposal

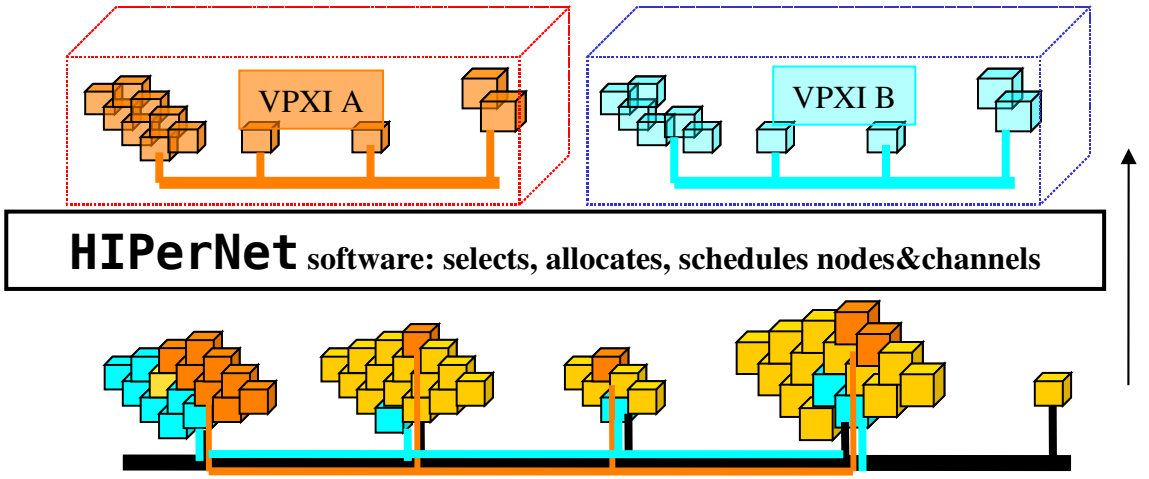
1) Unifying concept (VPN+Vgrid/Cloud)
2) Original description langage
3) Orchestration & configuration software
4) Customizable virtual router
5) Adaptation to reproducible experiments
6) Evaluation in a large scale testbed

V(PX)I : virtual infrastructure concept

A virtual (private execution) infrastructure : **V(PX)I** is defined in **VXDL** as:

- A list of **individual virtual resources** and groups
- A virtual **network topology** with weighted links (rate, latency…)
- The **executing timeline** of the application (for co-scheduling).

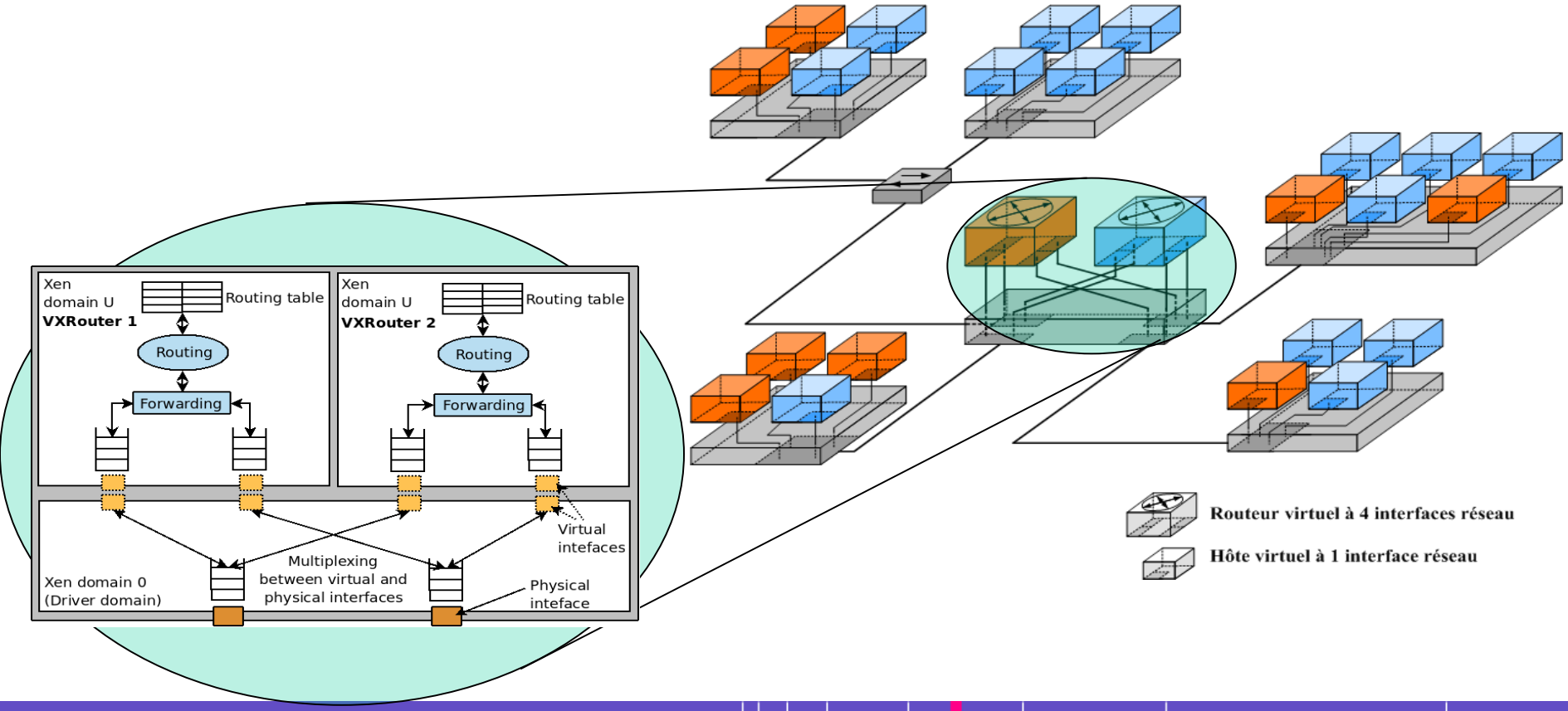




[Koslovski, Vicat-Blanc Primet. Grid05, GridNets08, ICNS09, CCGrid09]

Virtual Infrastructures building blocs

⇒Dynamic link provisioning
⇒Virtual software routers design (VXRouter)

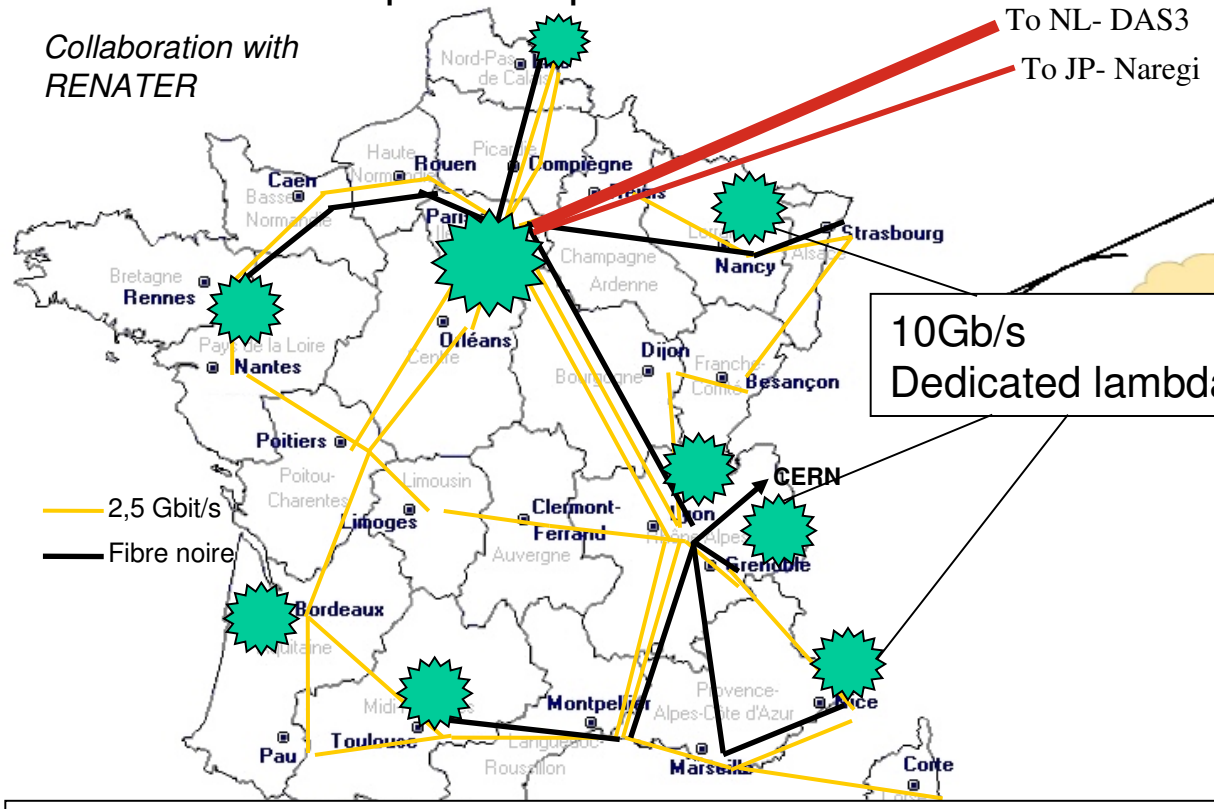


INRIA's experimental Cloud : Grid5000

⇒Grid5000 facility

- Resource mutualisation
- Reservation & reconfiguration features
- Over a private optical network

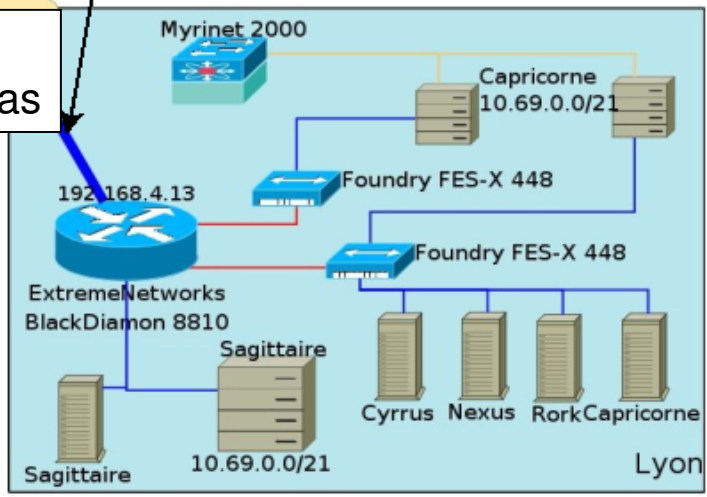
Collaboration with RENATER



Typical Grid5000 usage:

1. Connect to the platform on a site
2. Reserve a set of resources
3. Configure the resources (optional)
4. Run an experiment
5. Grab the results
6. Free the resources

10Gb/s
Dedicated lambdas



Grid5000@Lyon

[F. Cappello & al. Grid5000: a nation wide experimental grid testbed. in International Journal on High Performance Computing Applications, 2006.]

Grid'5000 as an instrument

4 main features:

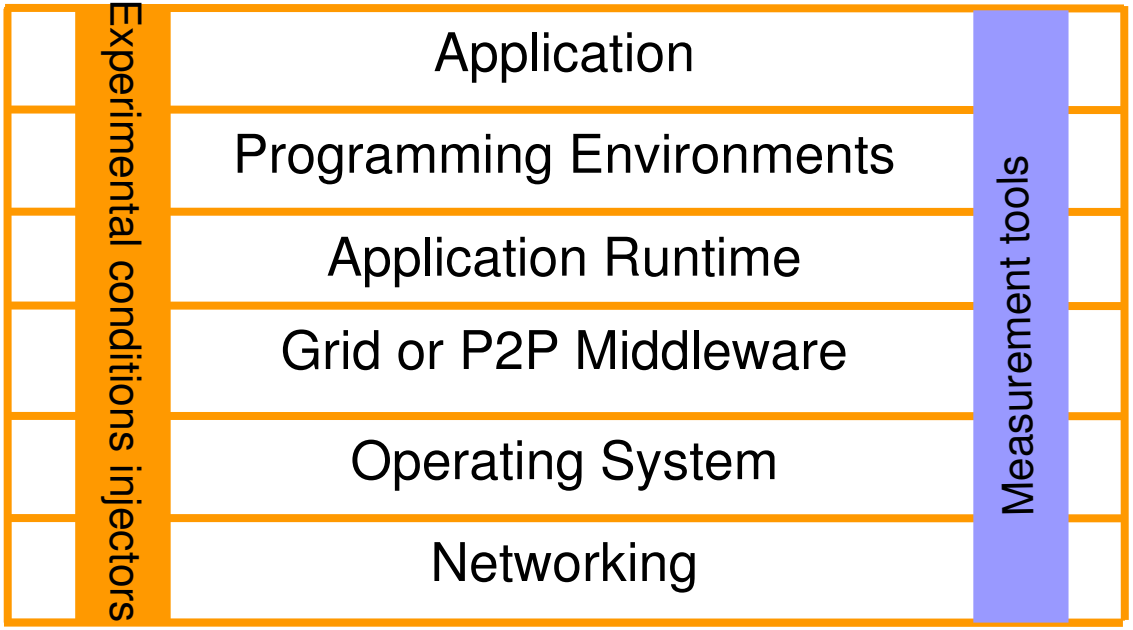
- A high security for Grid'5000 and the Internet, despite the deep reconfiguration feature
  --> Grid'5000 is confined: communications between sites are isolated from the Internet and Vice versa (level2 MPLS, Dedicated lambda).

- A software infrastructure allowing users to access Grid'5000 from any Grid'5000 site and have a simple view of the system
  --> A user has a single account on Grid'5000, Grid'5000 is seen as a cluster of clusters

- A reservation/scheduling tools allowing users to select nodes and schedule experiments
  --> A reservation engine + batch scheduler (1 per site) + OAR Grid (a co-reservation scheduling system)

- A user toolkit to reconfigure the nodes
  --> Software image deployment and node reconfiguration tool

Grid'5000 principle: A highly reconfigurable experimental platform



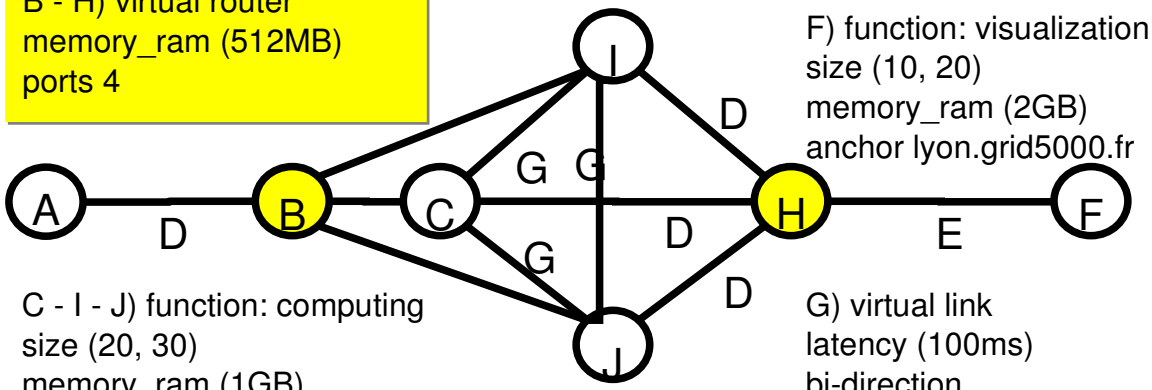
- Let us create, deploy and run their software stack, including the software to test and evalute the environment using measurement tools + experimental conditions injectors
- Grid5000 is a real powerfull & easy to use grid, used every day by 300 researchers

Virtual Infrastructure description

Grid5000 user's define their VPXI in **VXDL**

A) function: storage
size (10, 20)
hd_size (30GB, 60GB)

B - H) virtual router
memory_ram (512MB)
ports 4



E) virtual link
bandwidth (2Gbps, 3Gbps)
uni-direction
between [(H port 4,F)]

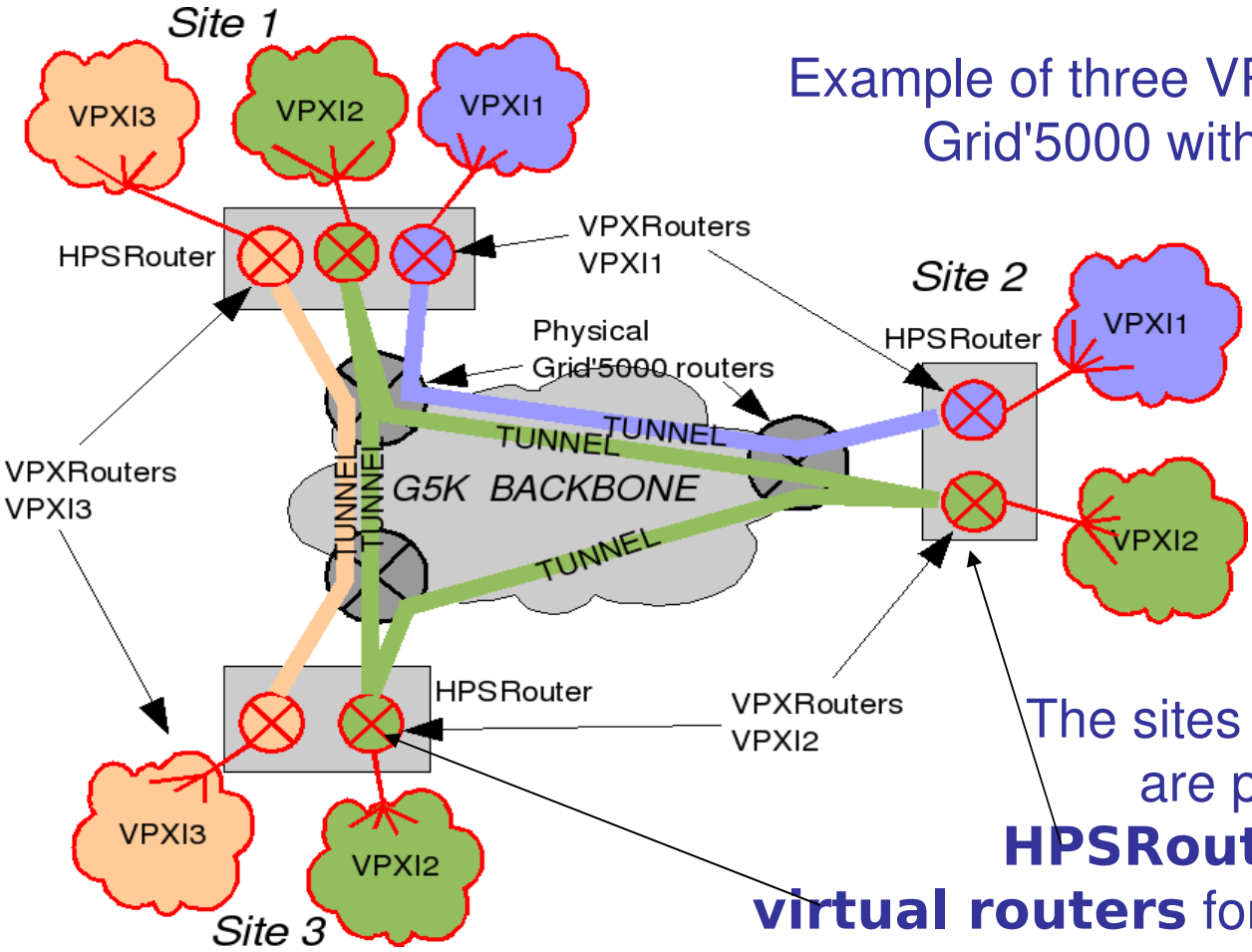
F) function: visualization
size (10, 20)
memory_ram (2GB)
anchor lyon.grid5000.fr

C - I - J) function: computing
size (20, 30)
memory_ram (1GB)

G) virtual link
latency (100ms)
bi-direction
between [(C,I), (I,J), (C,J)]

D) virtual link
bandwidth (1Gbps, 2Gbps)
uni-direction
between [(A, B port 1), (I, H port 1), (J, H port 2), (C, H port 3)]

HIPerNET's VPXI allocation on Grid'5000

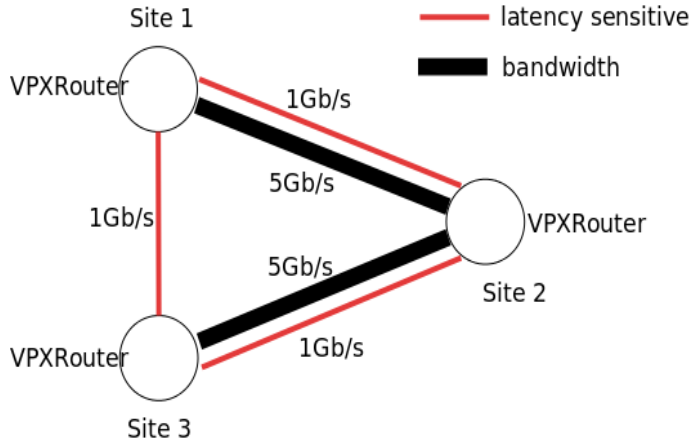


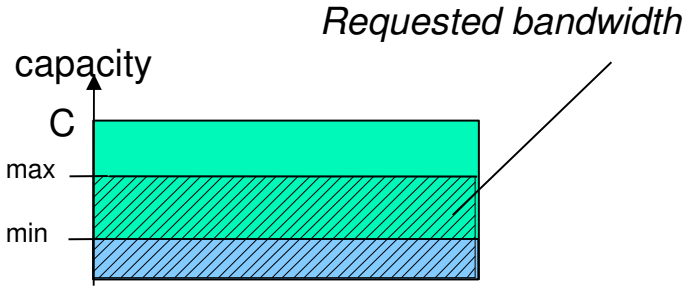
Example of three VPXIs allocated on Grid'5000 with HIPerNET

The sites of Grid'5000 are provided with **HPSRouters** hosting **virtual routers** for each VPXI.

Customized routing and bandwidth allocation VXcontrol

- HIPerNET exposes different bandwidth services:
  - Minimum guaranteed bandwidth:
    - guarantee the user a minimum bandwidth over its virtual links
    - *Cross_traffic < (C-min)*
  - Maximum allowed bandwidth:
    - Forbid the user's traffic to exceed a specified threshold
    - *User_traffic < (Max)*
  - Static bandwidth reservation:
    - guarantee a minimum bandwidth available and forbid to exceed a maximum
    - *Cross_traffic < (C-min) & User_traffic < (Max)*

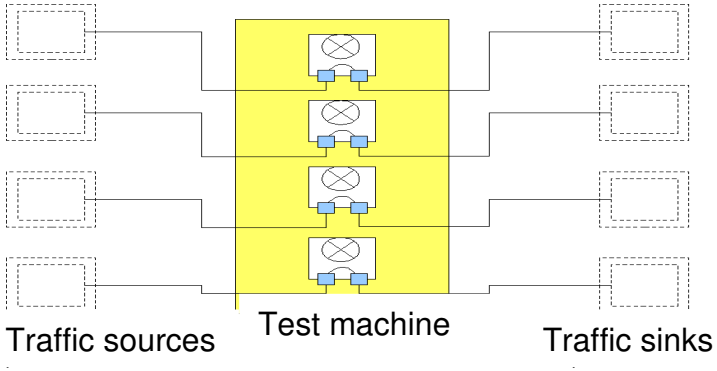




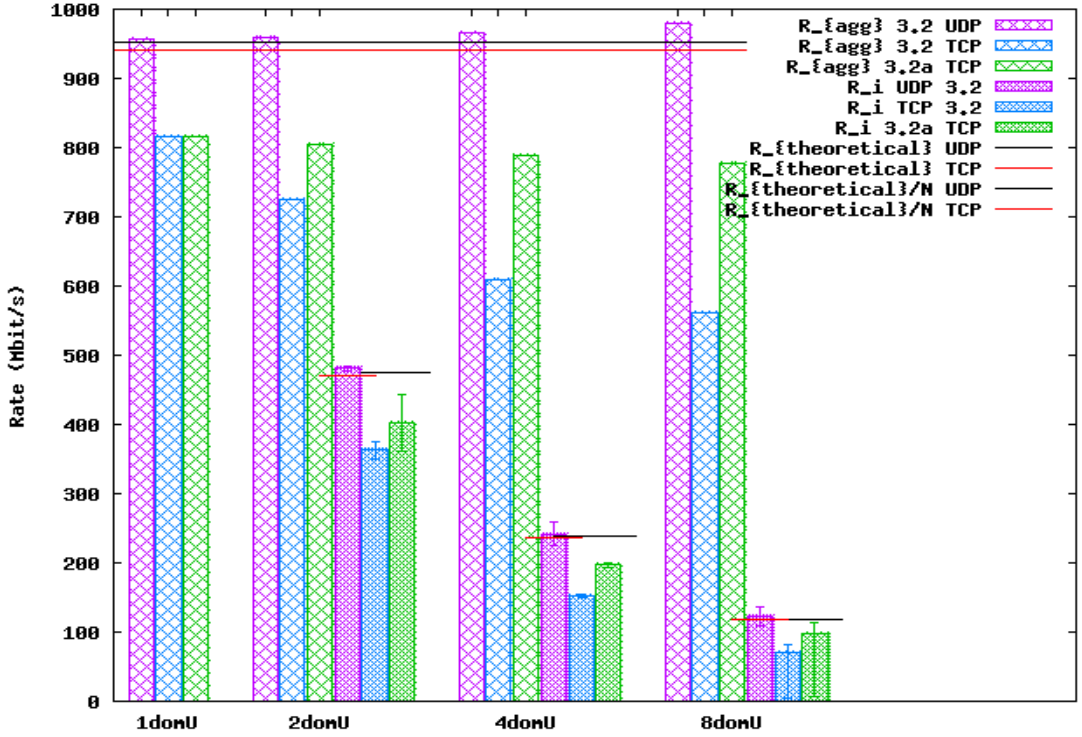
Experimental testplan and setup

- Goal 1: Virtual router performance
  - Xen 3.2 para-virtualization, Linux kernel 2.6.18
  - Netperf benchmark
- Goal 2: Rate control on virtual routers
  - Rate limitation with Linux trafic control tools
    - Token bucket filter (tbf)
    - Precise Software Pacer (PSPacer)
- Test platform
  - IBM eServers with 2 AMD Opteron CPUs, 2 GB of memory
  - 1 Gb/s NICs

Virtual network performance on virtual routers



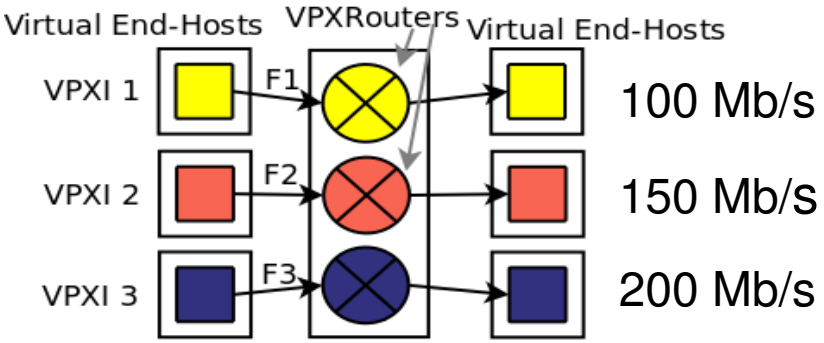
✘ Aggregate throughput low compared to theoretical throughput (941.49Mb/s)
✘ Rather fair bandwidth sharing



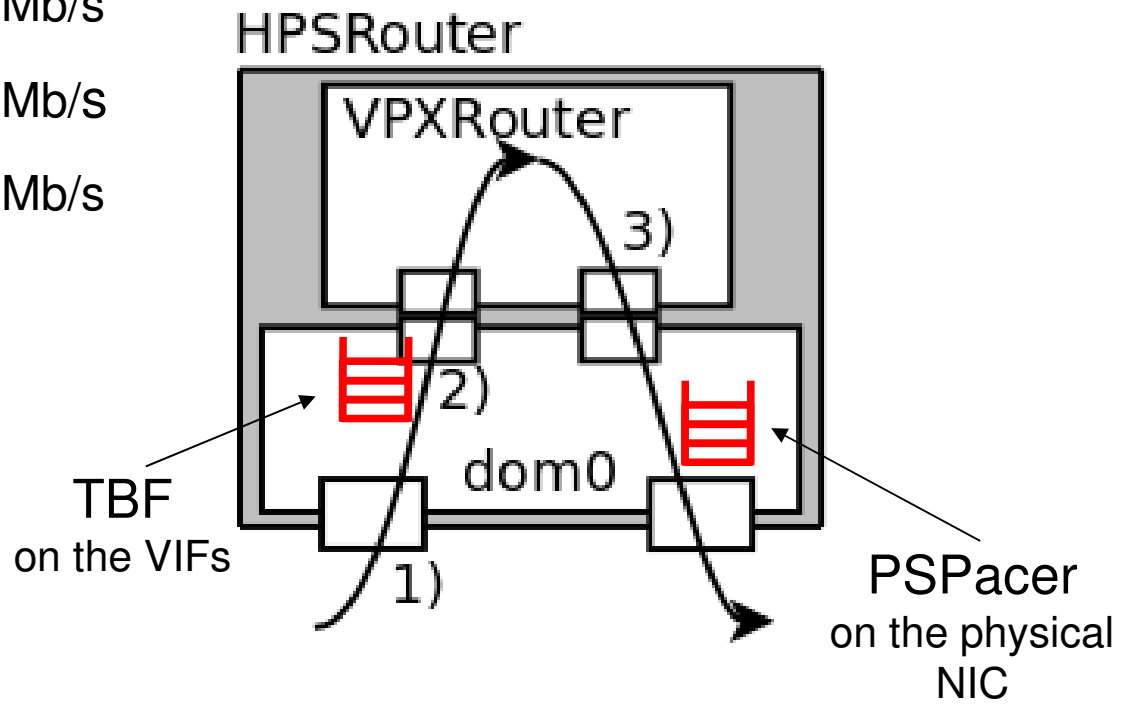
✓ Better throughput giving dom0 more CPU weight (3.2a)
✓ Improvement of scalability and predictability

Rate control (VXcontrol)

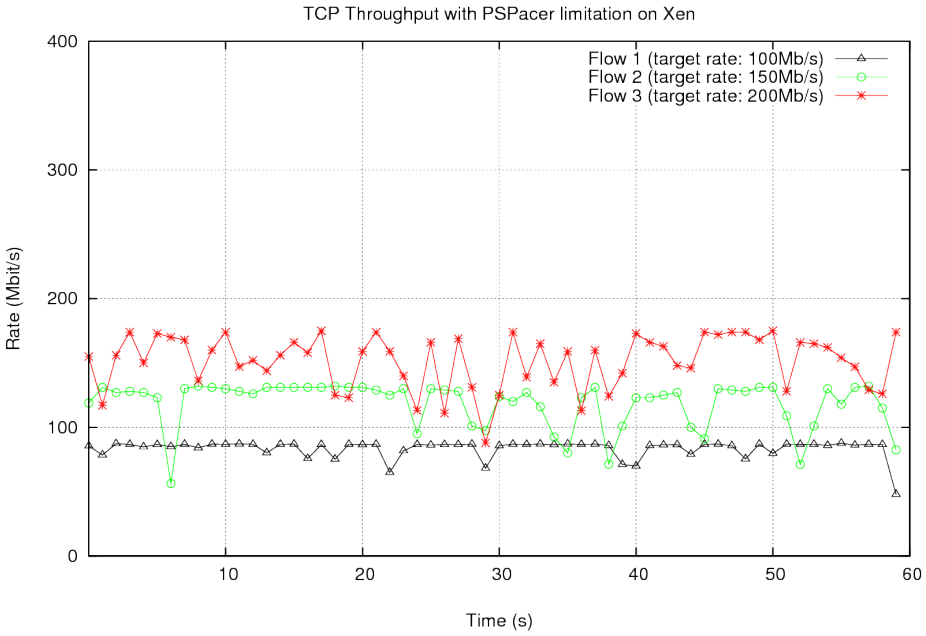
- Sending flows over three VPXIs with different static bandwidth reservations over the virtual routers



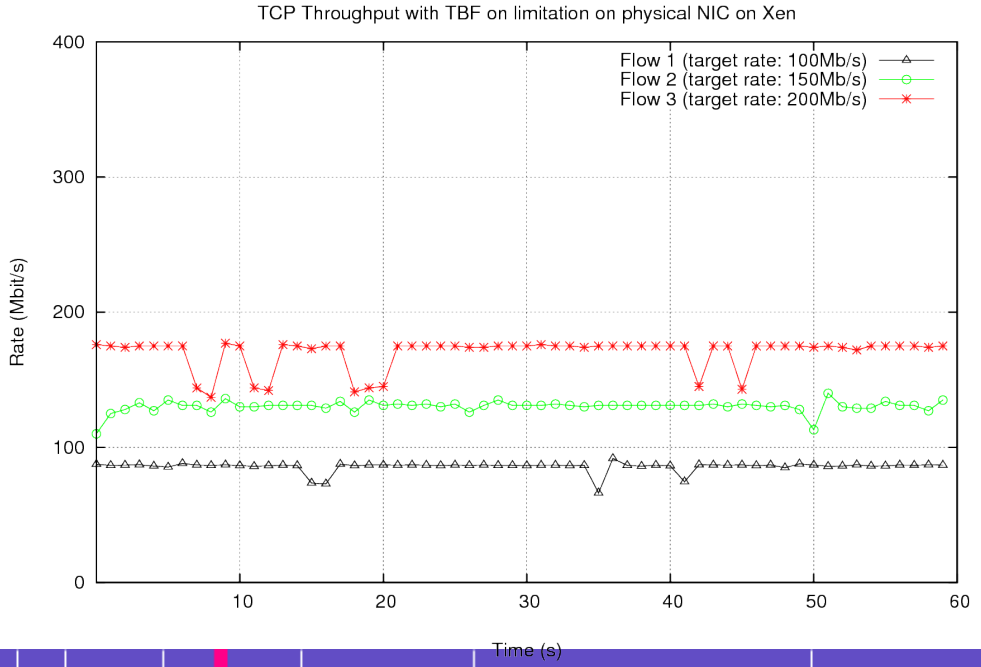
Comparison of two solutions of rate limiting inside the HPSRouter



Rate control: Results



PSPacer rate limitation on outgoing physical NIC (congestion factor = 0.9)



TBF rate limitation on the virtual NICs (congestion factor = 0.9)

Conclusion

Key points of our proposal:

1) Unifying concept:	**VPXI**
2) Original description langage:	**VXDL**
3) Orchestration & configuration software:	**HIPerNET**
4) Customizable virtual router:	**VXRouter**
5) Adaptation to reproducible experiments:	**VXcontrol**

Perspective: exploration of the full customization potential & isolation evaluation in a large scale with Grid5000 users

Thank you for your attention !

Any questions ?

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