VirtCloud: Virtualising Network for Grid Environments

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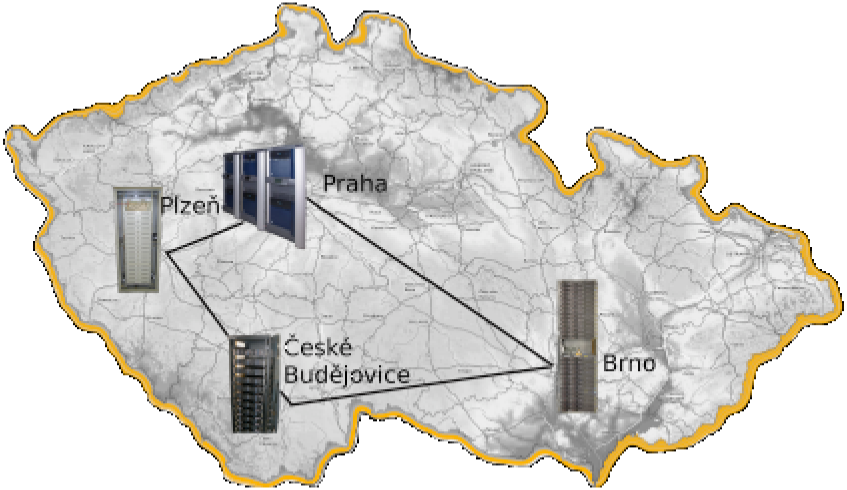
Motivation—The MetaCenter Situation

- Czech national Grid infrastructure (`http://meta.cesnet.cz`)
- computation nodes in Brno, Pilsen, České Budějovice, and Prague connected with Czech NREN CESNET2 (10GE)



MetaCenter and Virtualisation

- virtualisation
  - increasing user control of the infrastructure
    → "dumb&passive" network no longer sufficient
    → network support necessary
    → VirtCloud design (not specific to CESNET2)
- goal architecture: "logical cloud over physical grid"
  - grid: distributed, heterogenous, various owners and administrators
  - cloud: single owner and administrator, on-demand services

Virtual Network in Grid Computing

- traditionally: network as a fixed resource
- virtual clusters
  - (dynamically) mapped to the physical infrastructure
  - user controlled (by means of Grid middleware)
- virtualisation of networks
  - Virtual LAN—illusion of LAN over a more complex infrastructure
  - Virtual Private Networks—illusion of presence in a remote network
- our approach: network as “just another resource”
  - planned by resource planning system
  - using the backbone network, but not reconfiguring it

Main Use Cases I

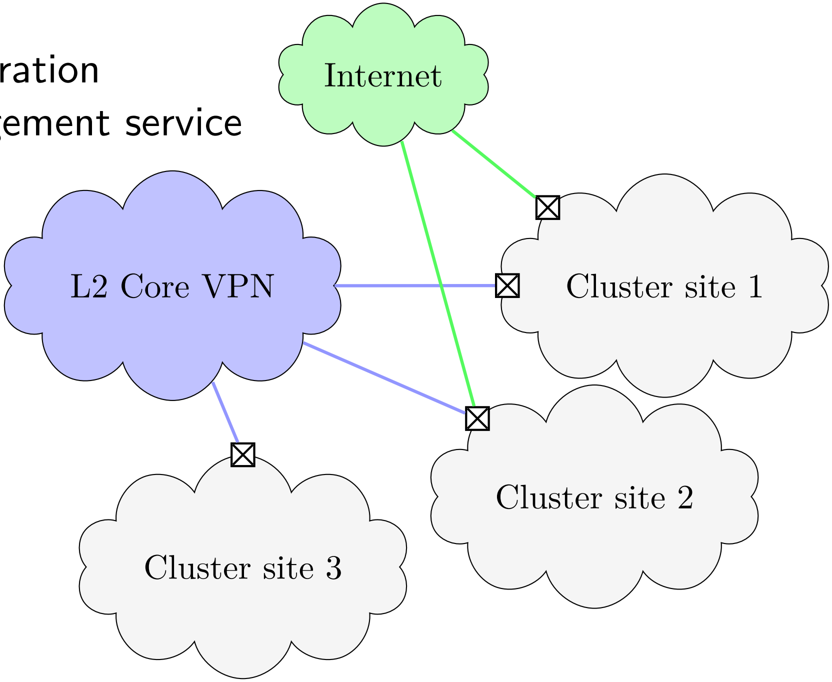
- user environment
  - user-provided OS image
  - user control over lifecycle of machines
  - even admin access for users
- privacy and security
  - mutual isolation of virtual clusters
    - user protection
  - legacy insecure components
  - controlling inbound/outbound traffic
    - attack/misuse prevention

Main Use Cases II

- networking
  - limited amount of IPv4 addresses
  - hardcoded IP addresses in machine images
    - ⋆ allowing multiple instances of such clusters
  - attaching the cluster to user's network
  - required high performance over a state-wide network
    - ⋆ without reconfiguring the backbone

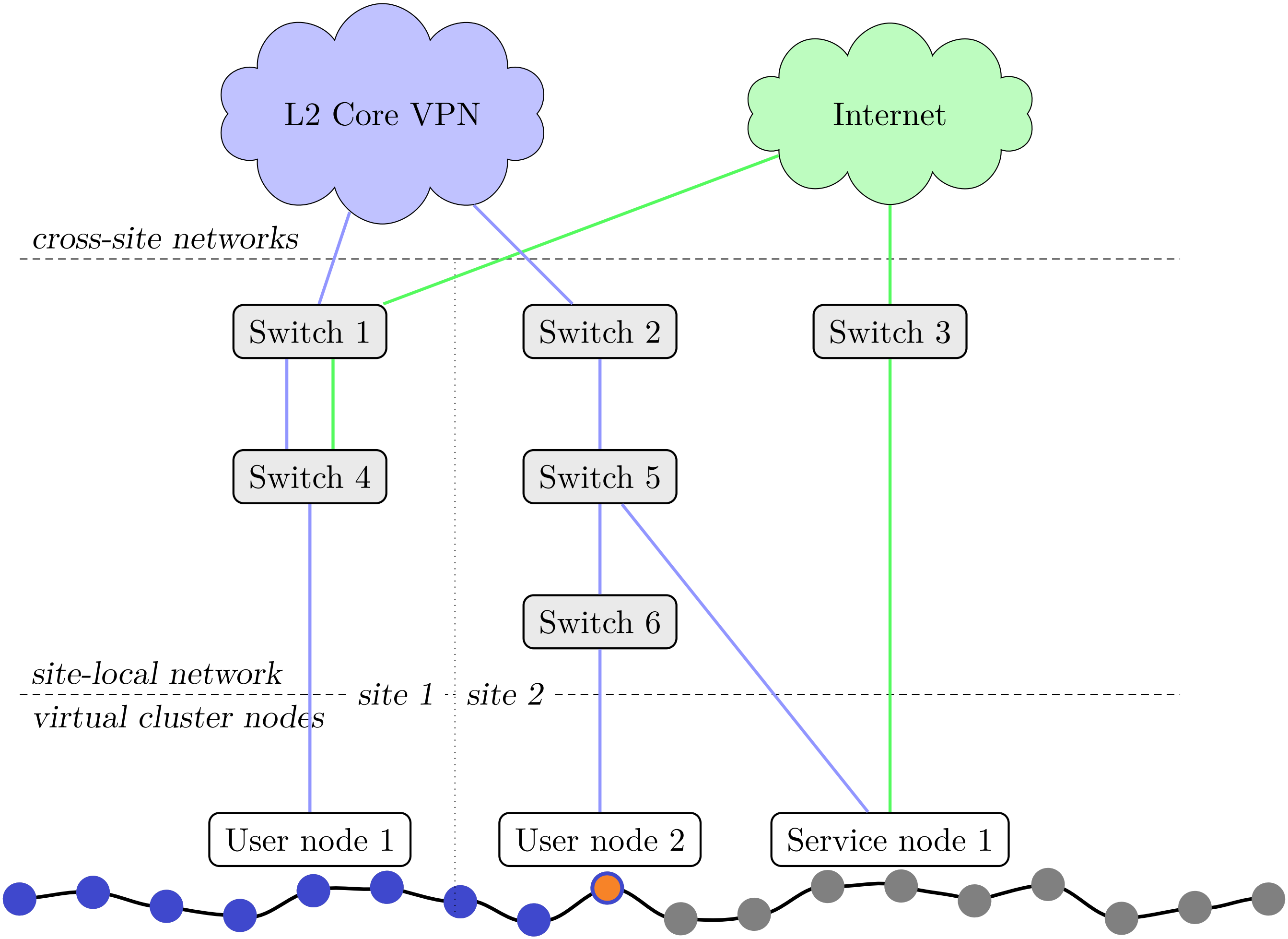
VirtCloud Architecture—Networking

- L2 core network (over the state-wide backbone)
- cluster site network
- (physical) host configuration
- VLAN life cycle management service



VirtCloud Architecture—Auxiliary Services

- managing and booting virtual machines
  - image repository
  - distributing images to physical nodes
  - booting virtual machines
- user access to a closed cluster
  - to allow users to use the cluster
  - connecting the cluster to user's home network
- getting basic services inside the cluster
  - DNS, network attached storage, . . .
  - preferably not via user's home network



L2 Core VPN

Internet

cross-site networks

Switch 1

Switch 2

Switch 3

Switch 4

Switch 5

Switch 6

site-local network

virtual cluster nodes

site 1

site 2

User node 1

User node 2

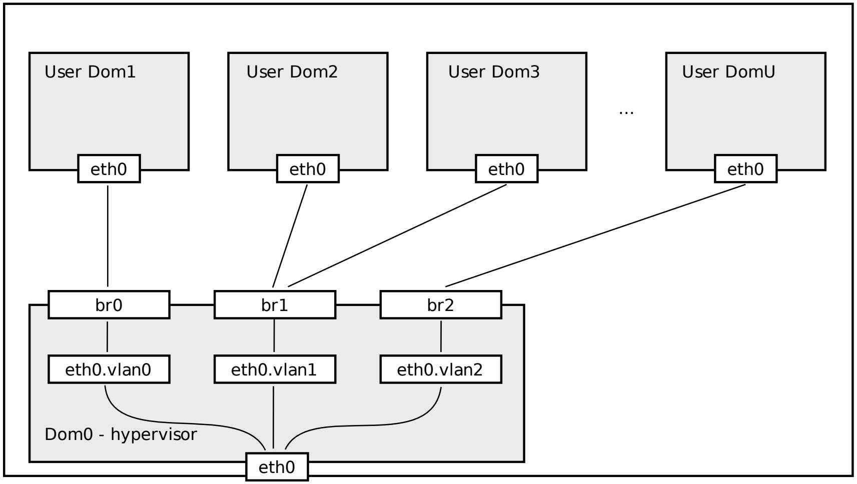
Service node 1

VirtCloud Implementation I

- core network—available technologies (only high-speed hardware-supported multipoint solutions)
  - Virtual Private LAN Service
  - Cisco Xponder
  - (IEEE 802.1ad (QinQ))
- site network: mix of Force10, HP, Cisco switches

VirtCloud Implementation II

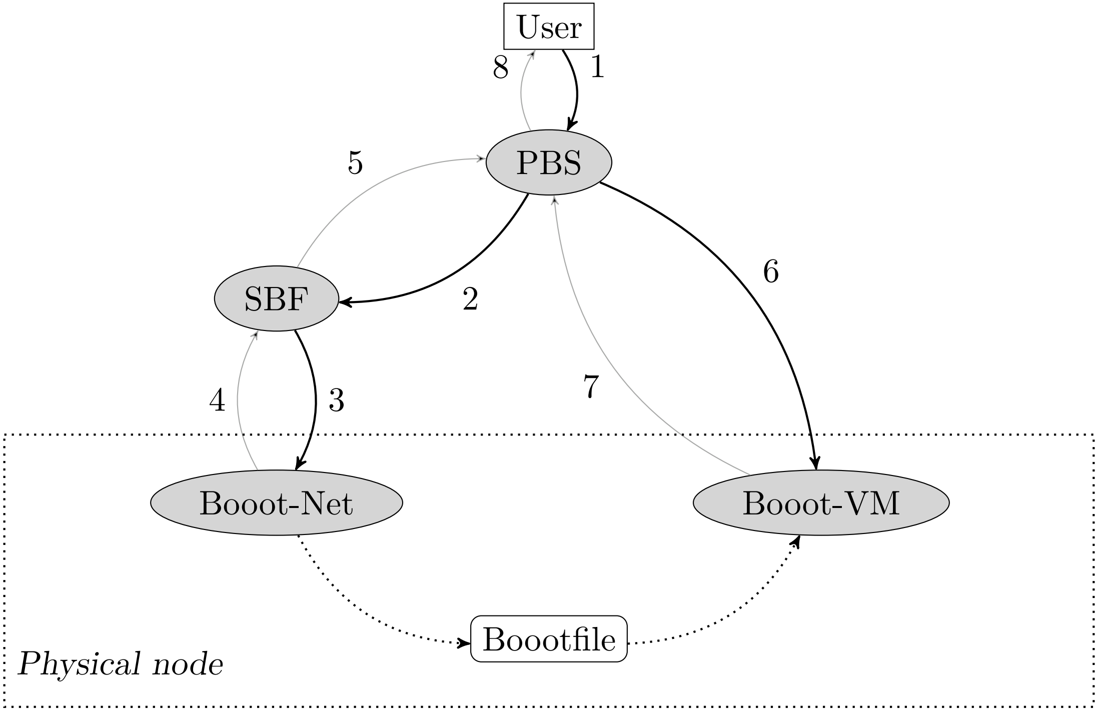
- host configuration
  - bridging in Xen hypervisor
  - Layer 3 addressing is user-driven



VirtCloud Implementation—Components

- job scheduling system
  - virtual cluster is a job for physical machines
  - PBS
- virtual network lifecycle management system
  - SBF
- managing host configuration and booting virtual machines
  - Booot-Net and Booot-VM

VirtCloud Implementation—Interactions



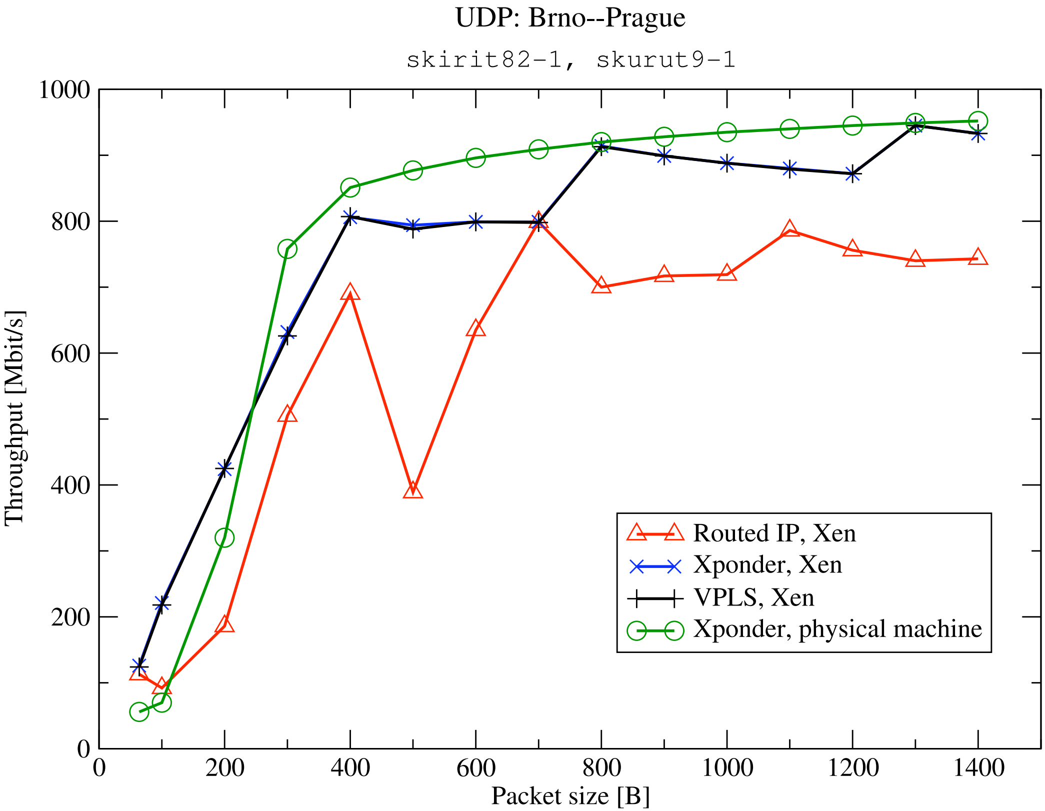
Access to (and from) Virtual Clusters

- implemented by a “service virtual machine”
  - booted with the cluster
  - user access from outside
    - external tunelling
      - OpenVPN (similar to Nimbus)
  - access to MetaCenter data/services
    - attaching the service to the virtual cluster
  - access to external resources
    - allowing the external traffic

First VirtCloud Experiences

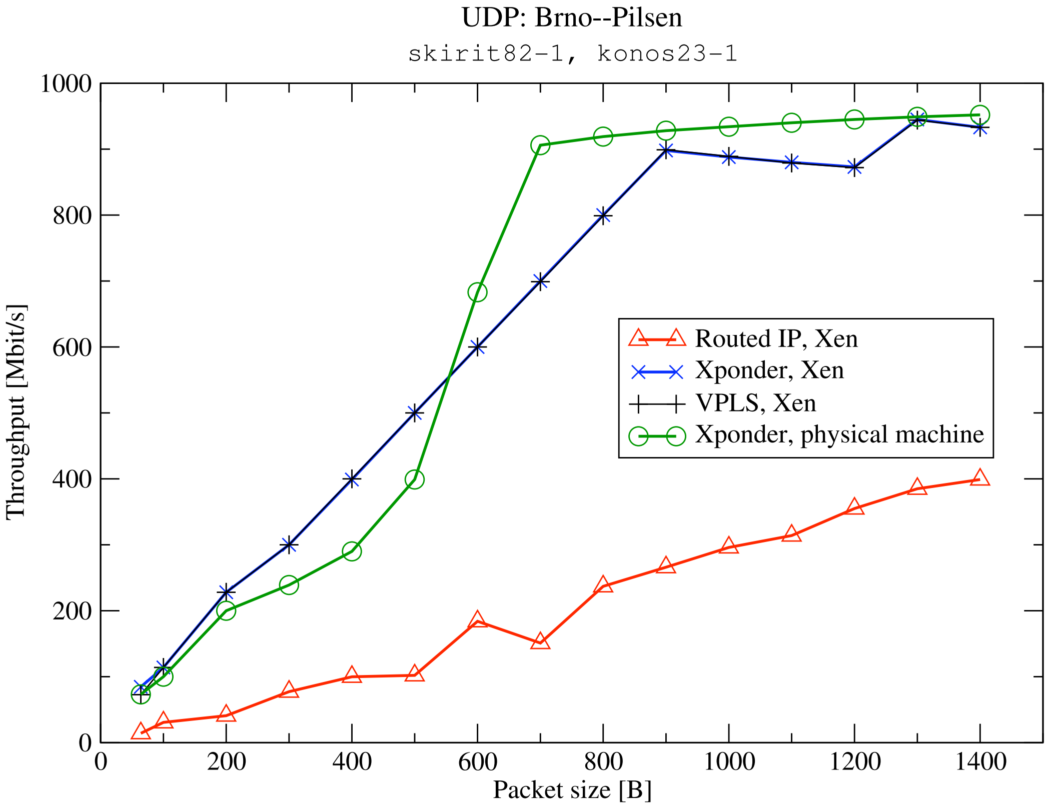
- interfering large-area networks has performance implications
- the preformance must not be significantly worse than of native IP network
- to show feasibility of the concept
  - stability tests
  - throughput tests comparing
    - Xponders in physical machines
    - Xponders in Xen user domain
    - VPLS in Xen user domain
    - native IP connection
  - iperf, UDP bandwidth with $< 0.5\%$ loss

Results I



UDP: Brno--Prague
skirit82-1, skurut9-1
Throughput [Mbit/s]
0
200
400
600
800
1000
Packet size [B]
0
200
400
600
800
1000
1200
1400
Routed IP, Xen
Xponder, Xen
VPLS, Xen
Xponder, physical machine

Results II


UDP: Brno--Pilsen
skirit82-1, konos23-1
Throughput [Mbit/s]
Packet size [B]
0
200
400
600
800
1000
0
200
400
600
800
1000
1200
1400
Routed IP, Xen
Xponder, Xen
VPLS, Xen
Xponder, physical machine

Conclusion

- architecture of VirtCloud, a system for internetworking dynamic virtual clusters over a large high performance network
- analysis, architecture, implementation
- evaluation: feasible
- future work
  - strategies of external resource access
  - integration of components
  - concepts of virtual machine migration
  - filesystems (home and scratch)