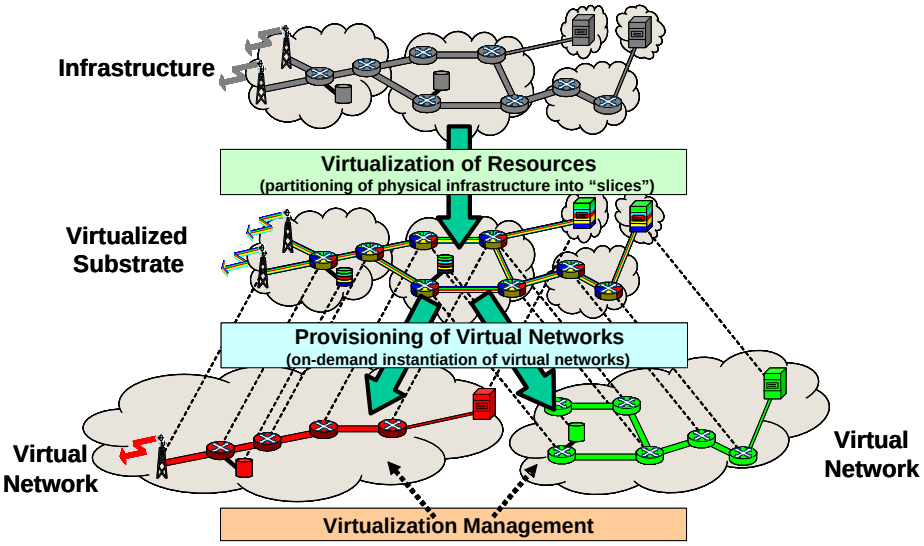
Enabling Alternative Internet Architectures

Network Virtualization Architecture: Proposal and Initial Prototype

Network virtualization scenarios

- Virtual network
  - Resource isolation
  - Different architecture/protocol per virtual network
    - Does not have to be IP protocol
    - Some with some QoS and security
  - Expose network components to applications and services
    - Overcome Internet impassé
  - Dynamic
    - New ones will come and old ones will go
    - Migration / Expansion / Contraction
  - Multiple networks in parallel == diversity
- Simplify network management and service offerings
- Virtual networks != VPN – VPN is just a service!
  Virtual networks != P2P network – P2P is just an overlay

Virtualization: Vision



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Benefits of virtualization

- Overcome ossification of network core
  - Isolation as enabler for new technologies
    - Traditional: IPv6, multi-cast, …
    - CSD: novel network architectures
  - Deployment of innovative products
  - Network diagnosis
- Efficient utilization of resources
  - Migration of devices (such as routers) – similar to server virtualization
  - Traffic load balancing ("migration" of links)
- New business opportunities
  - Sharing of physical resources (e.g., T-Mobile UK and 3 UK)

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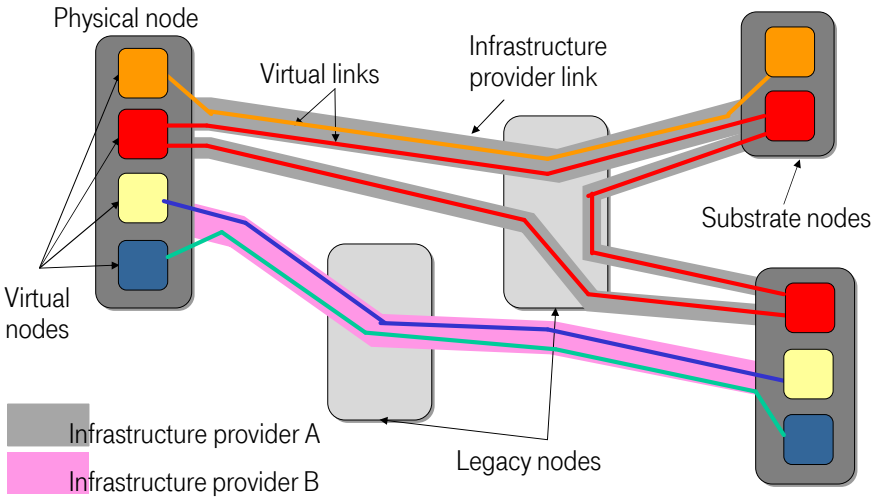
Virtual network – terminology



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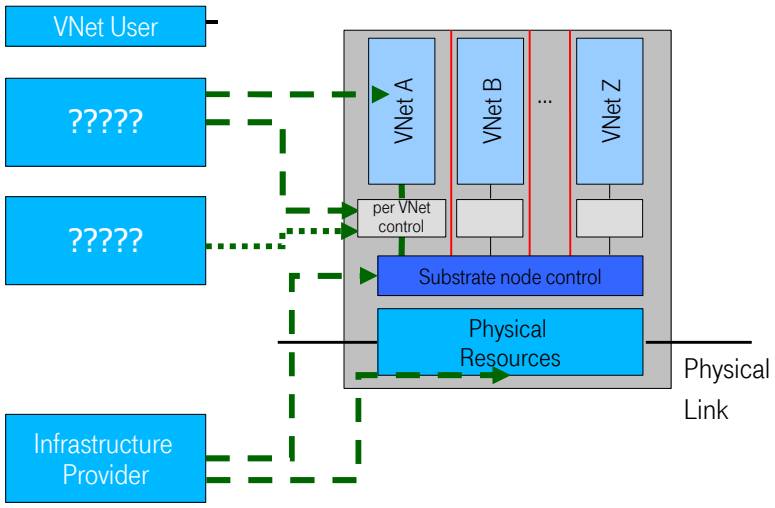
Virtual node – terminology



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Roles in the Internet

- Traditional roles:
  - Service providers (SP)
    - Google, World of Warcroft, …
  - Internet Service Providers (ISPs)
    - Deutsche Telekom, AT&T, …
- Recently:
  - Physical infrastructure provider (PIPs)
  - Bit-pipe providers
  - Service providers (SP)

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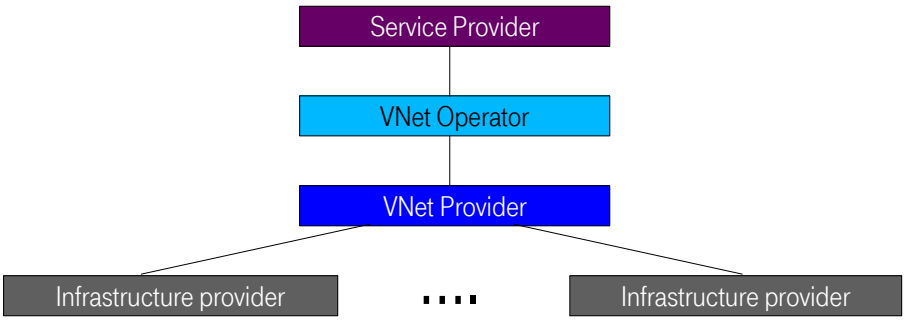
Roles with network virtualization



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Tasks: Birdseye view

- Physical Infrastructure Provider (PIP)
  - Provides Virtual Resources + Resource Control Interface
- VNET Provider (VNP)
  - Assembles virtual networks
  - Intuitively: provides layer of indirection
- VNET Operator (VNO)
  - Operates, controls, manages virtual networks (e.g., comparable to NOC)
- Service provider (SP)
  - Offers the service

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Physical Infrastructure Provider

- Services:
  - Provides Virtual Resource
  - Resource Control Interface
- Input:
  Requests for virtualized resources from VNP
- Task:
  - Creation of topology (constituents)
  - Pointers to virtual resources
  - Resource Control Interface
    - Virtual Node Bootstrapping
    - Interconnection

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VNET Provider (VNP)

- Service:
  - Instantiated virtual networks
    (interconnected virtual nodes with bootstrapping environment)
  - Handles contracts with PIP and VNO.
- Input: Abstract request for VNet
- Task:
  - Identify appropriate PIPs
  - Negotiate contracts
  - Partition network topology and acquire partial VNETs and Control Interfaces
  - Assemble virtual networks and control interfaces from partial VNETs provided by PIPs

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VNET Operator (VNO)

- Service:
  - Bootstraps, operates, controls, manages fully instantiated virtual network
  - Operates on virtual resources, identified by Identifiers (not Locators)
- Input: Interconnected virtual network
- Task: operating, managing of virtual network

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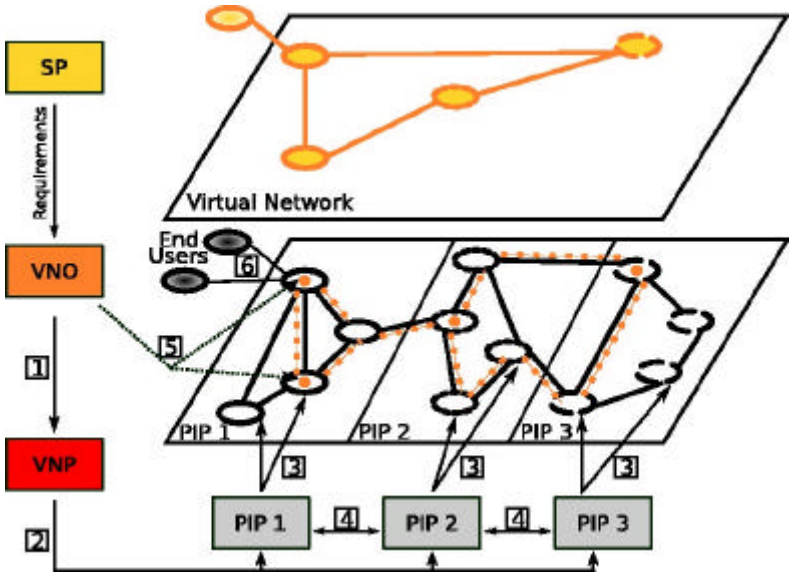
Control interfaces



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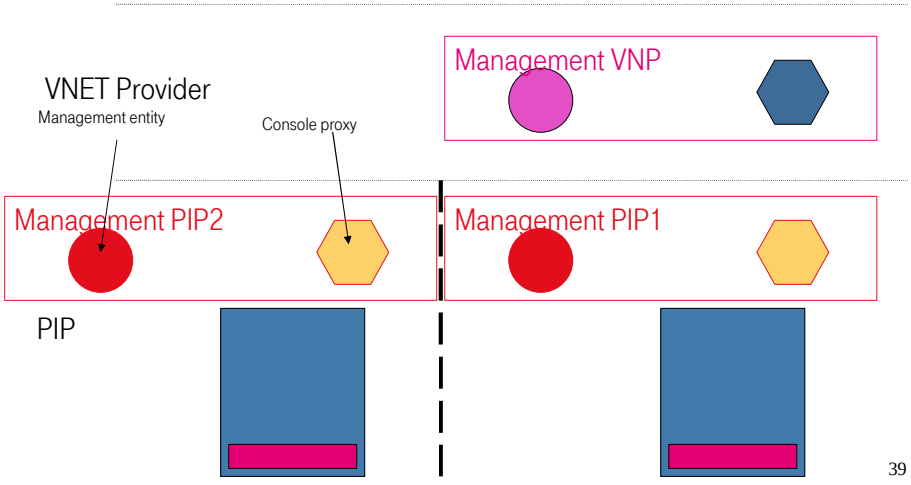
VNET signaling and control



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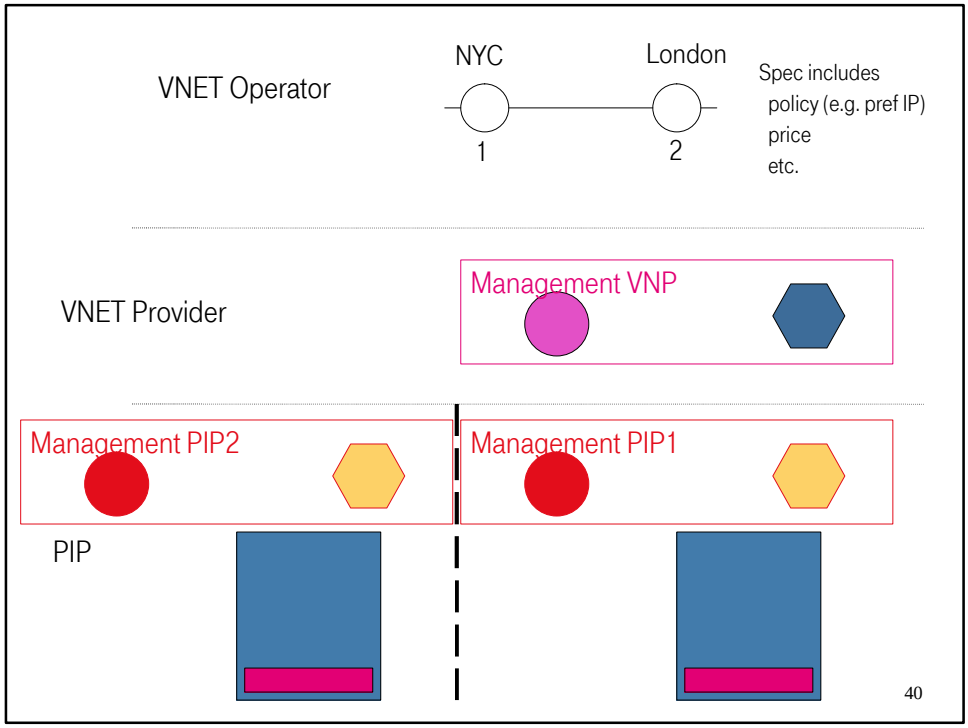
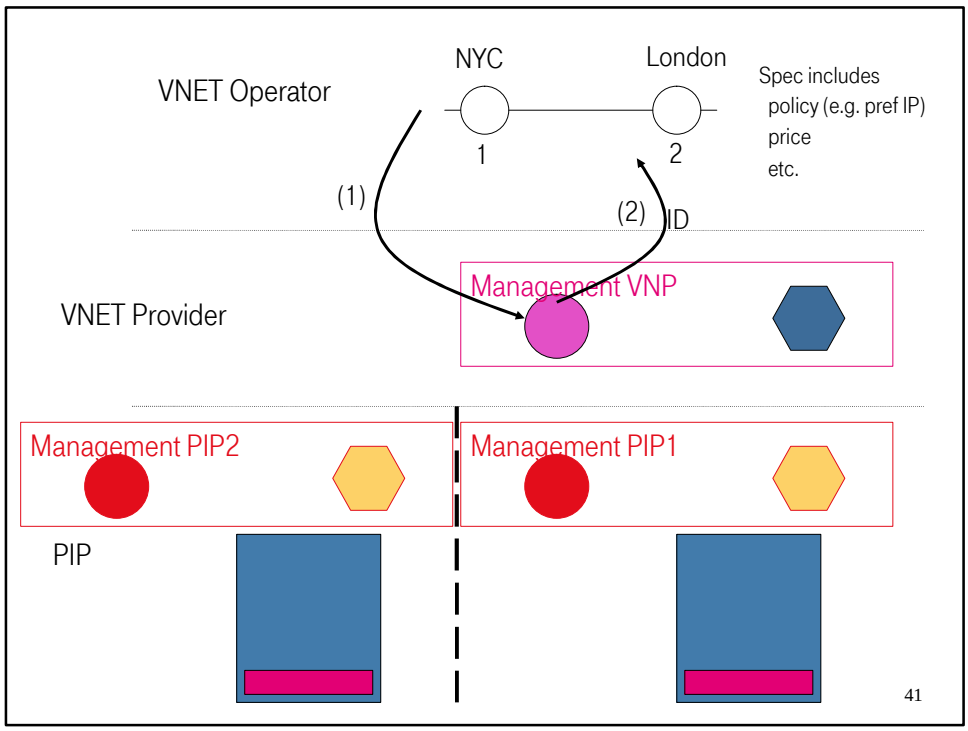

VNET Operator
NYC
London
1
2
Spec includes
policy (e.g. pref IP)
price
etc.
VNET Provider
Management VNP
Management PIP2
Management PIP1
PIP
40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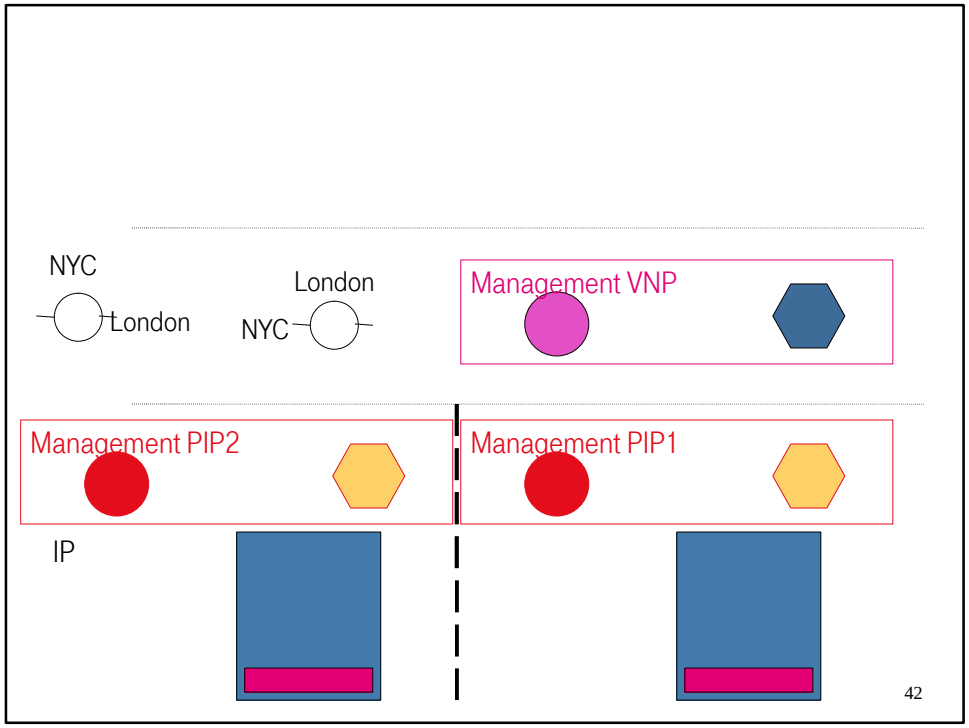
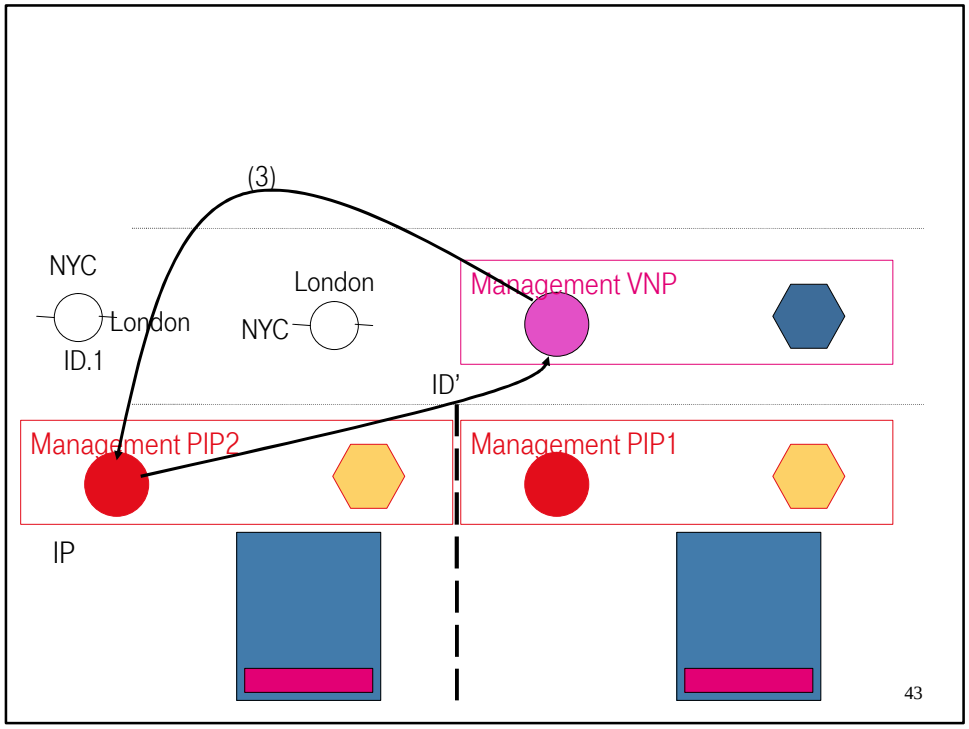
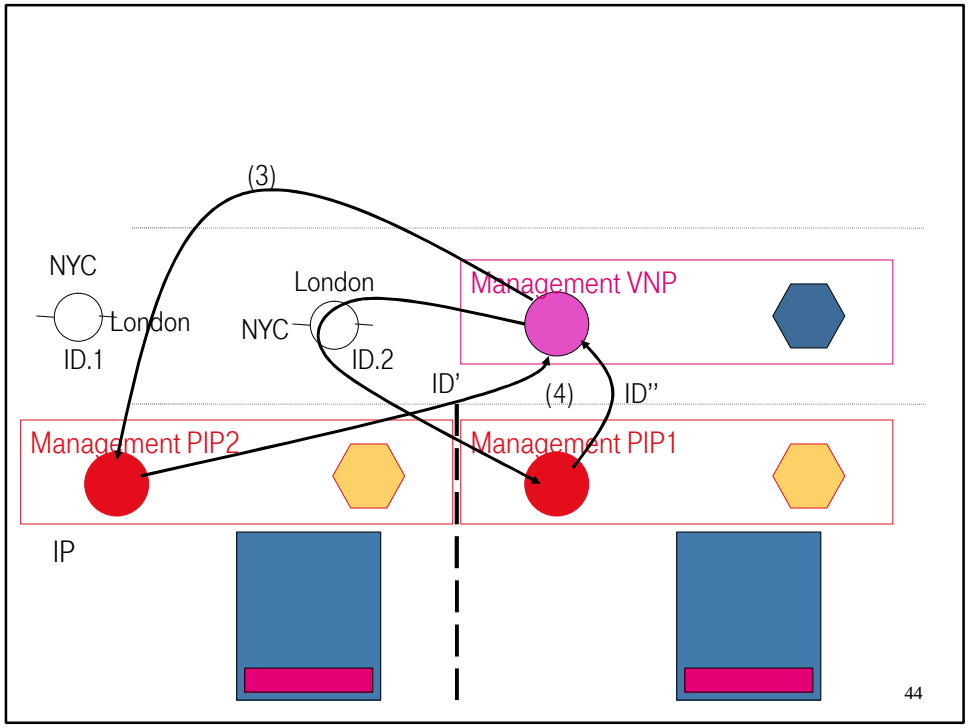
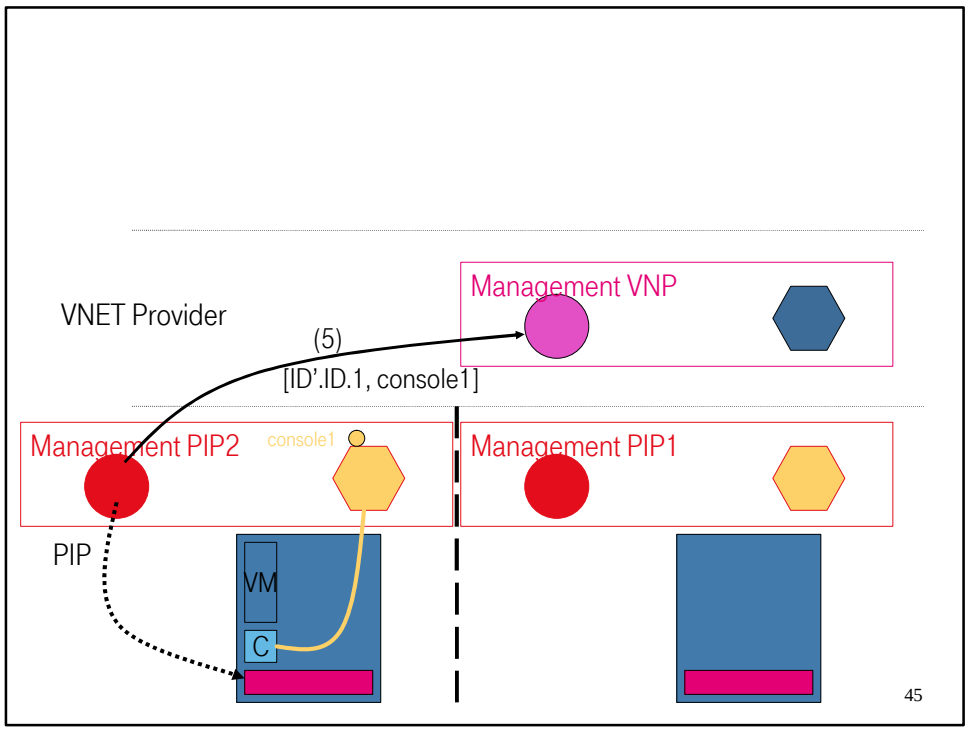
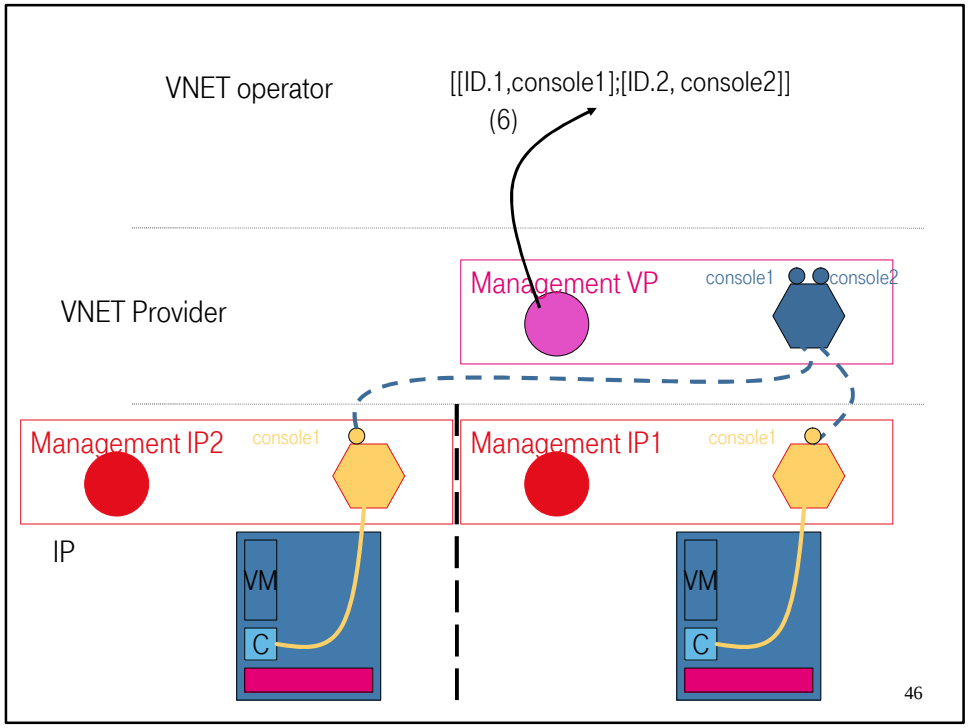
(1)
(2) ID
VNET Provider
Management VNP
Management PIP2
Management PIP1
PIP
41


NYC
London
London
NYC
Management VNP
Management PIP2
Management PIP1
IP
42


(3)
NYC
London
ID.1
London
NYC
Management VNP
ID'
Management PIP2
Management PIP1
IP
43


(3)
NYC
London
ID.1
London
NYC
ID.2
Management VNP
ID'
(4)
ID''
Management PIP2
Management PIP1
IP
44


Management VNP
VNET Provider
(5)
[ID'.ID.1, console1]
Management PIP2
console1
Management PIP1
PIP
VM
C
45


VNET operator
[[ID.1,console1];[ID.2, console2]]
(6)
VNET Provider
Management VP
console1
console2
Management IP2
console1
Management IP1
console1
IP
VM
C
VM
C
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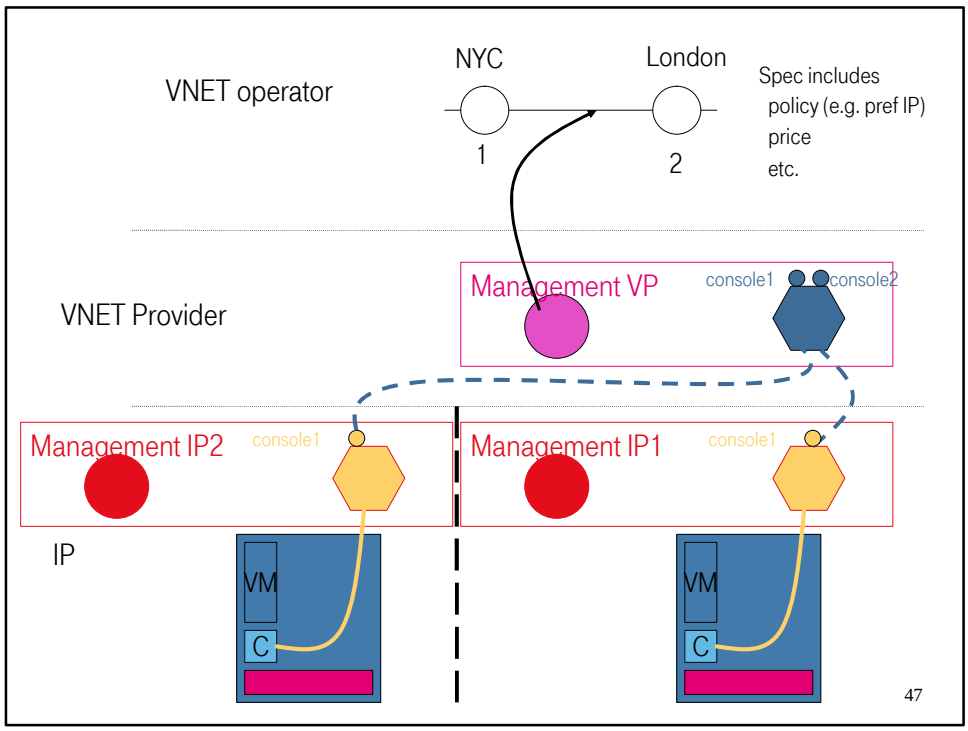
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VNET Provider
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console1
console2
Management IP2
console1
Management IP1
console1
IP
VM
C
VM
C
47

Lessons learned

- Isolate tasks ⇨ business opportunities
  - E.g.: Magnitude of the investment cost
    - AT&T plans to invest 17–18 Bn $ in 2009 compared to a revenue of 124 Bn $ in 2008
    - Deutsche Telekom plans to invest 8.7 Bn Euro compared to revenues of 62 Bn Euro in 2008

    1% is substantial!
- Don't forget control interfaces
- Interprovider issues are tricky
- Indirection and resource isolation are great tools

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