# Network Virtualization: from a Network Provider Perspective

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# Virtualization: What do I mean?

- Abstraction concept
  - Hides details of the hardware
  - Provides layer of indirection
- Virtualization offers
  - Isolation & separation
  - Resource sharing
    - Reuse
    - Statefull

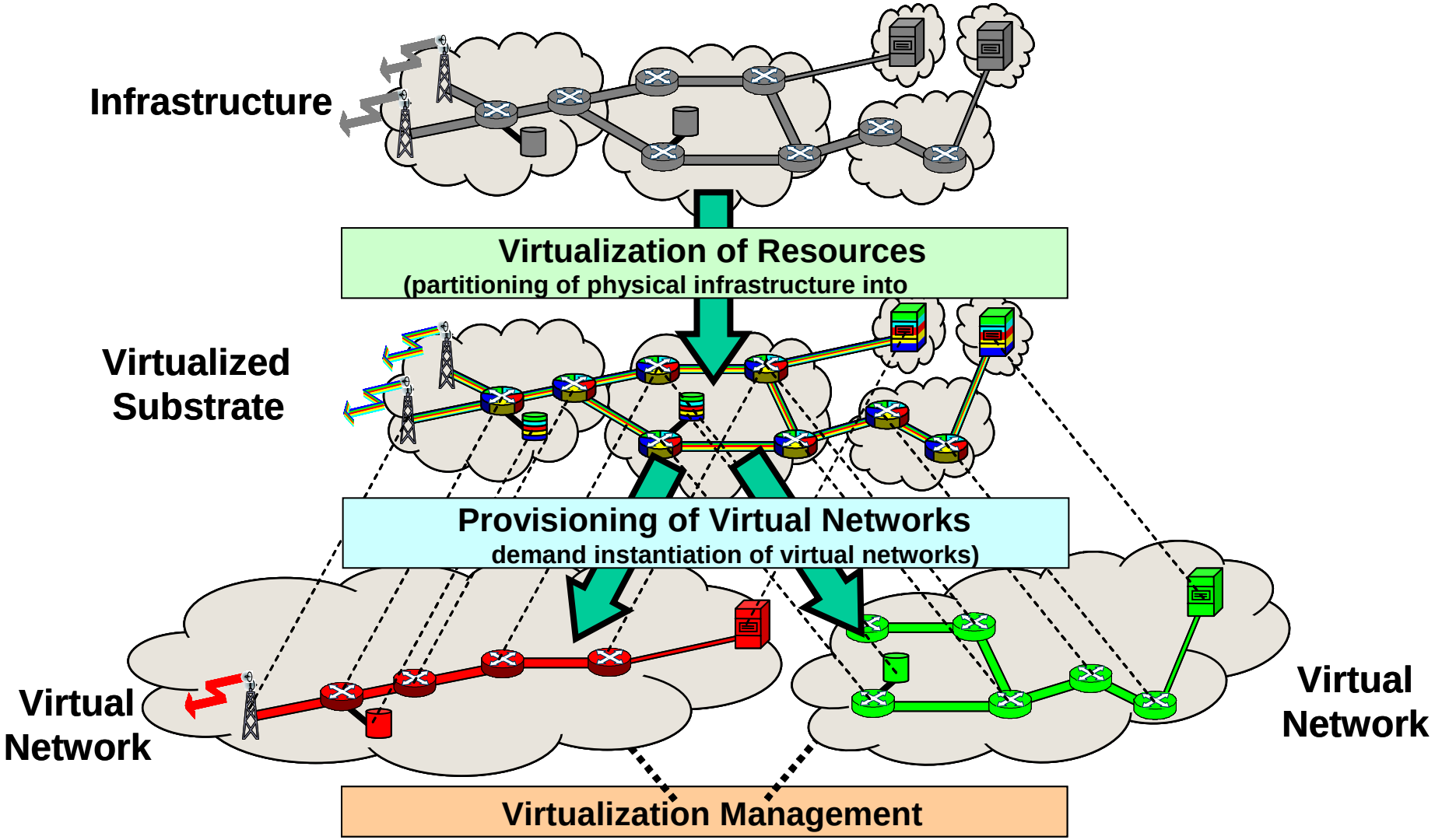
# Virtualization: Successes

- Virtual servers
- Cloud services
- ...

Why?

- Resource efficiency
- Simplified management!!!!

# Virtualized networks



# Virtual networks ==

- Combination of
  - Server and
  - Networking resources
- Slices of
  - Routers
  - Links
  - Servers
  - End-systems / hosts

# Virtual networks: Scenarios

- Different architecture/protocol per VNet
  - Does not have to be IP protocol
  - Some with some QoS and security

⇒ Multiple networks in parallel == diversity

- Expose network components to apps/services

⇒ Overcome Internet impassé

- Combines cloud with networking

⇒ New service ideas

# Virtual networks: Scenarios (2)

- Dynamic
  - New ones will come and old ones will go
  - Migration / Expansion / Contraction

⇒ Efficiency and new management capabilities

⇒ Designed for change

# Virtual networks !=

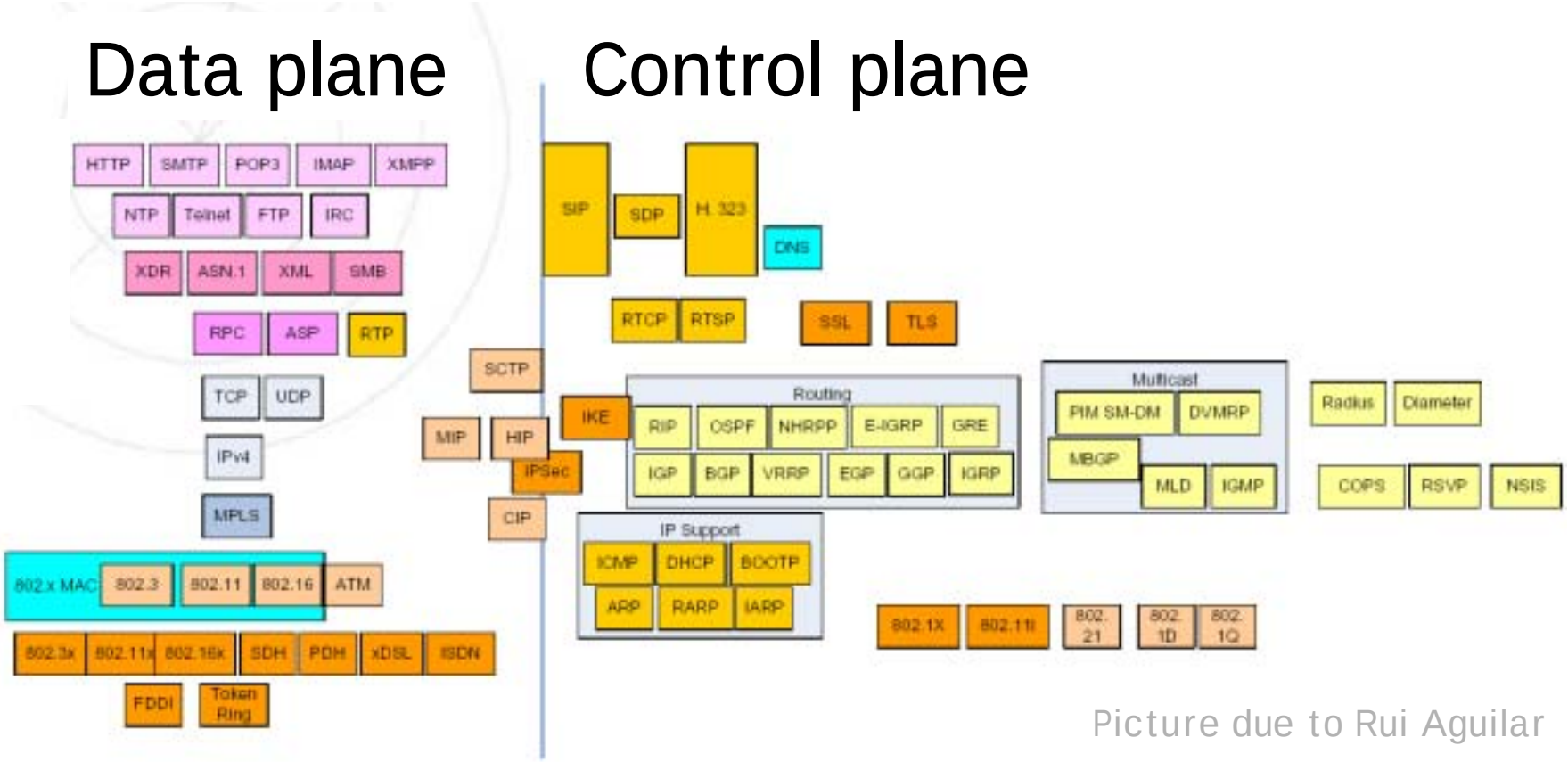
- Virtual private networks (VPNs)
  - VPN is just a service!
- P2P networks
  - P2P is just an overlay!

- Virtual networks should offer
  - Simplified network management
  - Simplified service offerings
  - Business opportunities

# Why now?

- Hardware support
  - Servers, Routers, switches, links, ...
  - Significant computational resources in the network
  - Fast packet forwarding hardware, e.g., OpenFlow
- Reality
  - Due to regulation, e.g., DSL access in Germany
- Need to revisit network management!
  - Internet problems:
    - Availability and reliability
    - Security
    - Scale and diversity
    - Support for new applications
    - Economics

# Today's Internet – out of shape!!!




Picture due to Rui Aguilar

- Redesign needed?

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    - Support for new applications
    - Economics
  - ☞ **All of the these are control plane issues!**

# Case study: Interprovider Issues and Business Opportunities

# Efficient utilization of resources

- Business challenge

  E.g.: Magnitude of 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

⇒ **Even 1 % is substantial!**

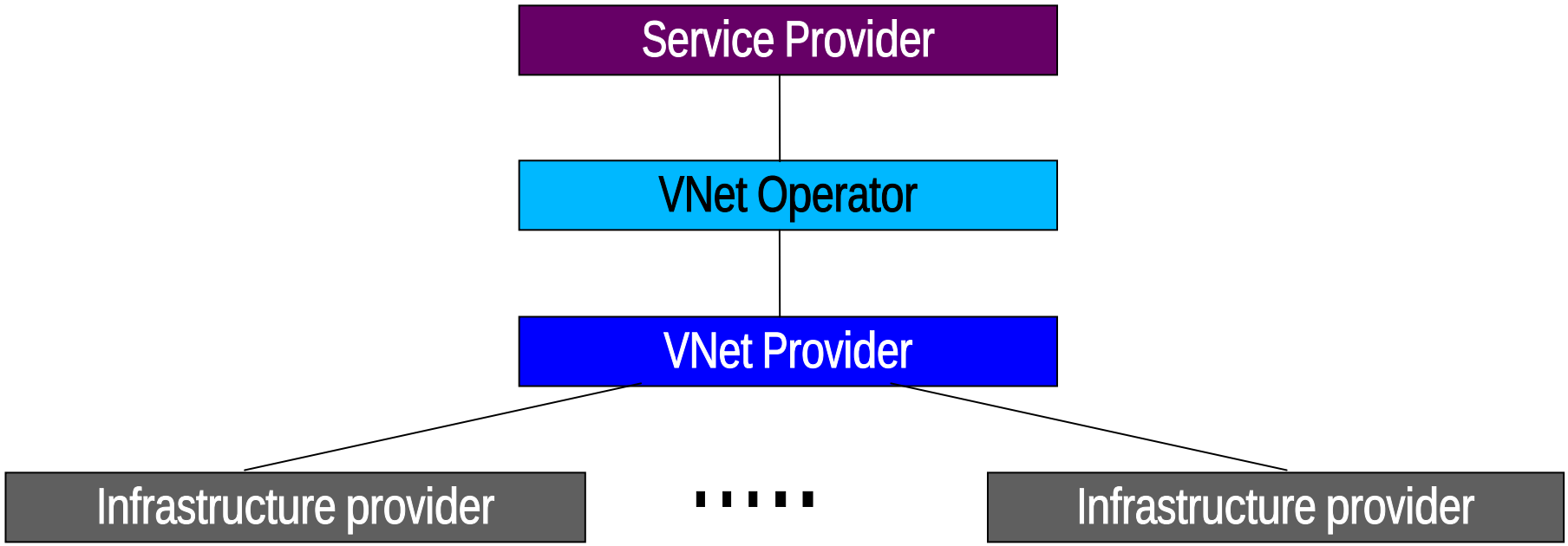
# Efficient utilization of resources (2)

- Technical opportunities
  - Migration of devices (such as routers)
    – similar to server virtualization
  - Traffic load balancing (“migration” of links)
  - Allocation of resources: In what chunks? and when?
- New business opportunities
  - Sharing of physical resources
    E.g., T-Mobile UK and 3 UK

# 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)

# Roles with network virtualization



# Tasks: Birdseye view

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

# Lessons learned

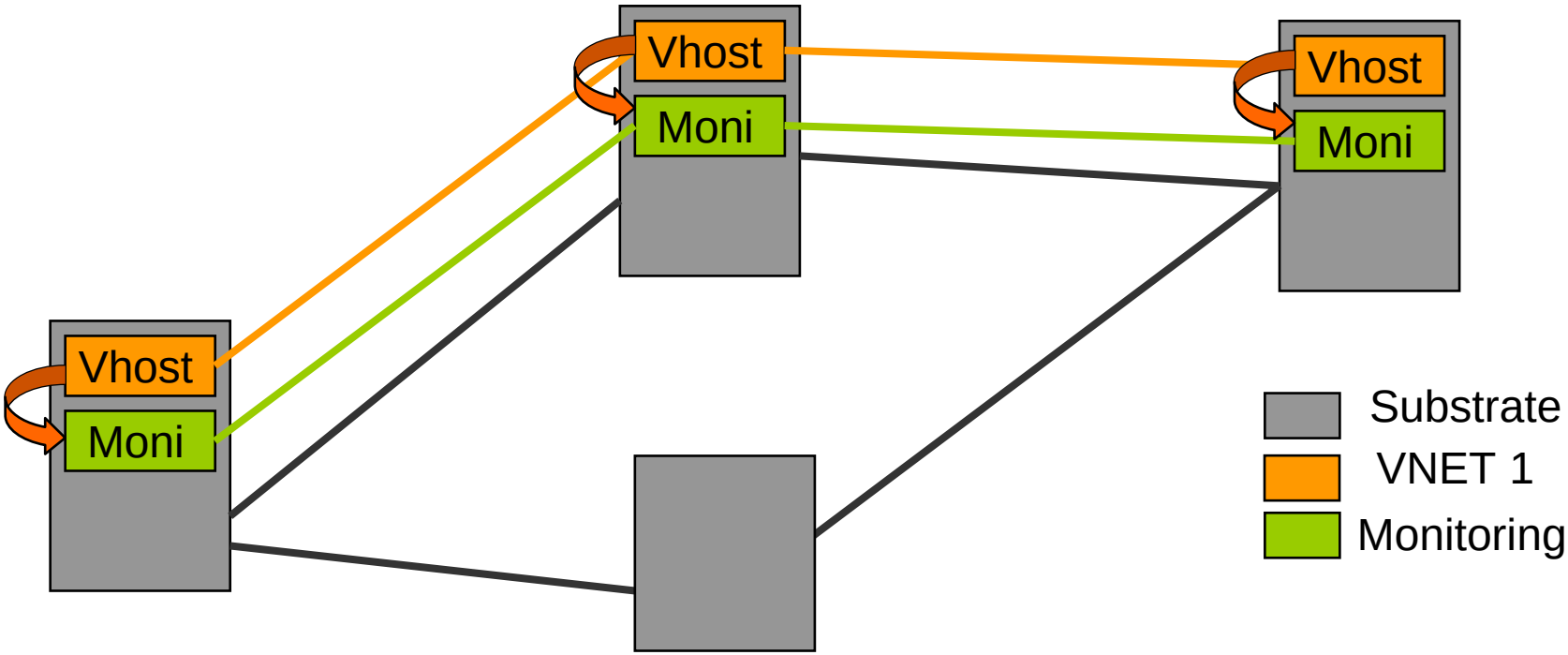
- Isolate tasks => business opportunities
  - E.g.: Magnitude of the investment cost
    even 1% is substantial!
- Don’t forget control interfaces
- Inter provider issues are tricky
- Indirection and resource isolation are great tools

# Case study:
# Network diagnosis
# aided by
# network virtualization

# Network diagnosis

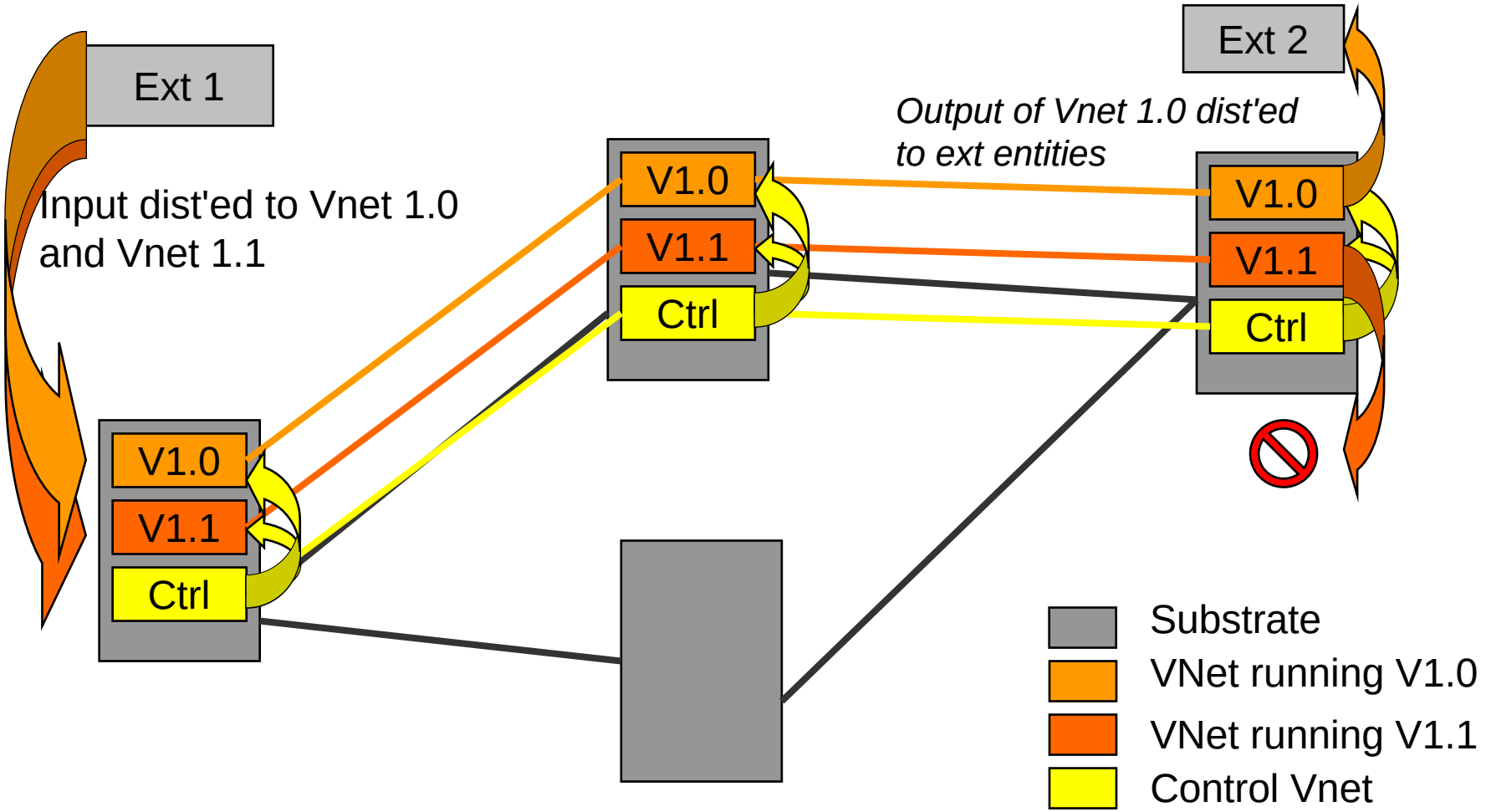
- Problem:
  Implementation/configuration issue surface in large-scale, long-term deployments with real user traffic
- Goal:
  - Do not change network under test
  - Avoid probe effect
- Diagnosis methods:
  - Instrumentation
  - Testing
    - Performance improvements
    - Regression testing
    - New software releases

# Instrumentation




- Pair production VNet with monitoring VNet
- Copy all/selected packets to monitoring VNet
- Processing is accounted to monitoring VNet

# Testing – ShadowVNet



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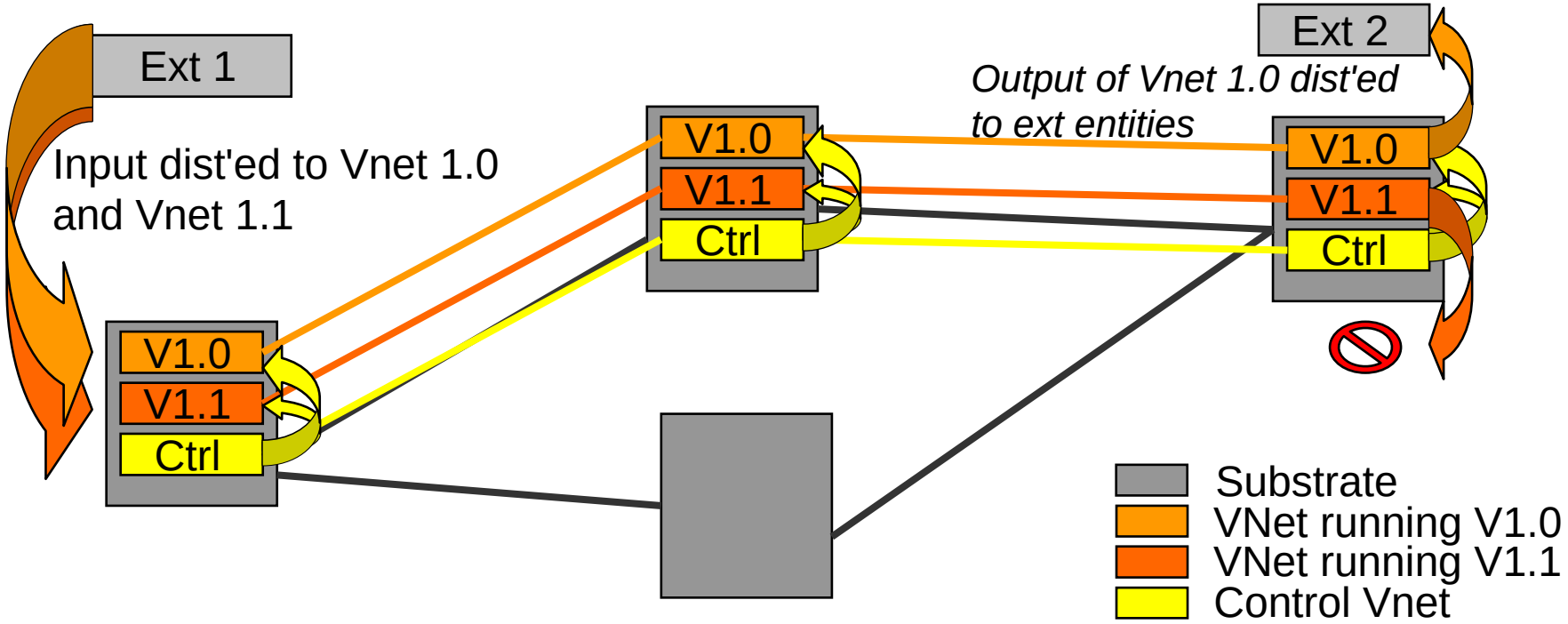



- Run VNet1.0, VNet1.1 monitoring VNet
- Distribute external input to both VNet1.0 and VNet1.1
- Ctrl compares output behavior of VNet1.0 and VNet1.1 for semantic equality
- Only output of VNet1.0 is distributed to external entities

# Assumptions

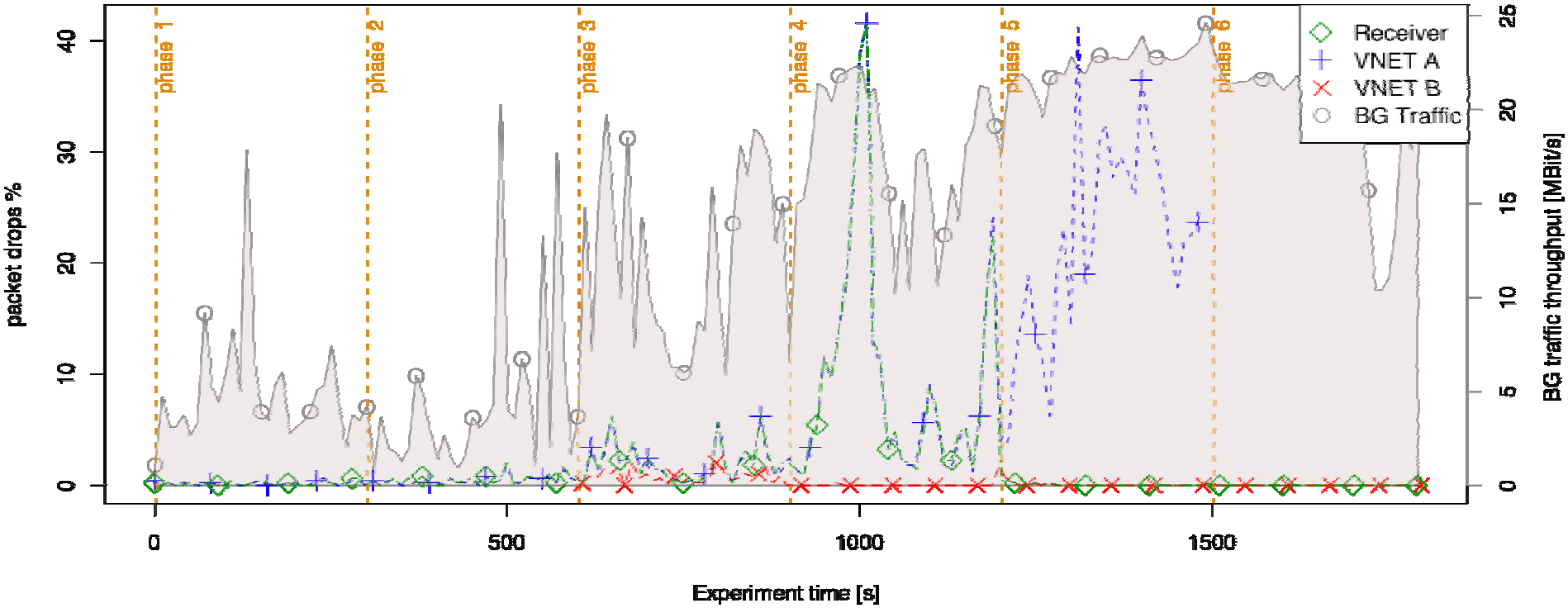
- Many VNets
  - ⇒ Reasonable # of resource per VNet
  - ⇒ Resource consumption for ShadowVNet OK
- Ability to clone VNets
  - Option A: Clone configuration
  - Option B: Live local migration (without delete)
  - Option C: Live remote migration (without delete)
- Ability to duplicate input traffic
  - E.g., monitoring features of network devices
- Ability to have resource isolation
  - E.g., via OpenFlow

# ShadowVNets – realistic?

- Per device?
  - Examples exist: E.g.,
    - BGP on Cisco Routers
- But: Problems usually arise due to
  - Complex networks and
  - User interactions

- ShadowVets to the rescue
  - See Sigcomm demo

# Example: VoIP with background load




- Phase 1: Minimal background traffic
- Phase 2: Background traffic increases
- Phase 3: Start ShadowVNet: VNET B
- Phase 4: Enable QoS in VNET B
- Phase 5: VNET B becomes operational

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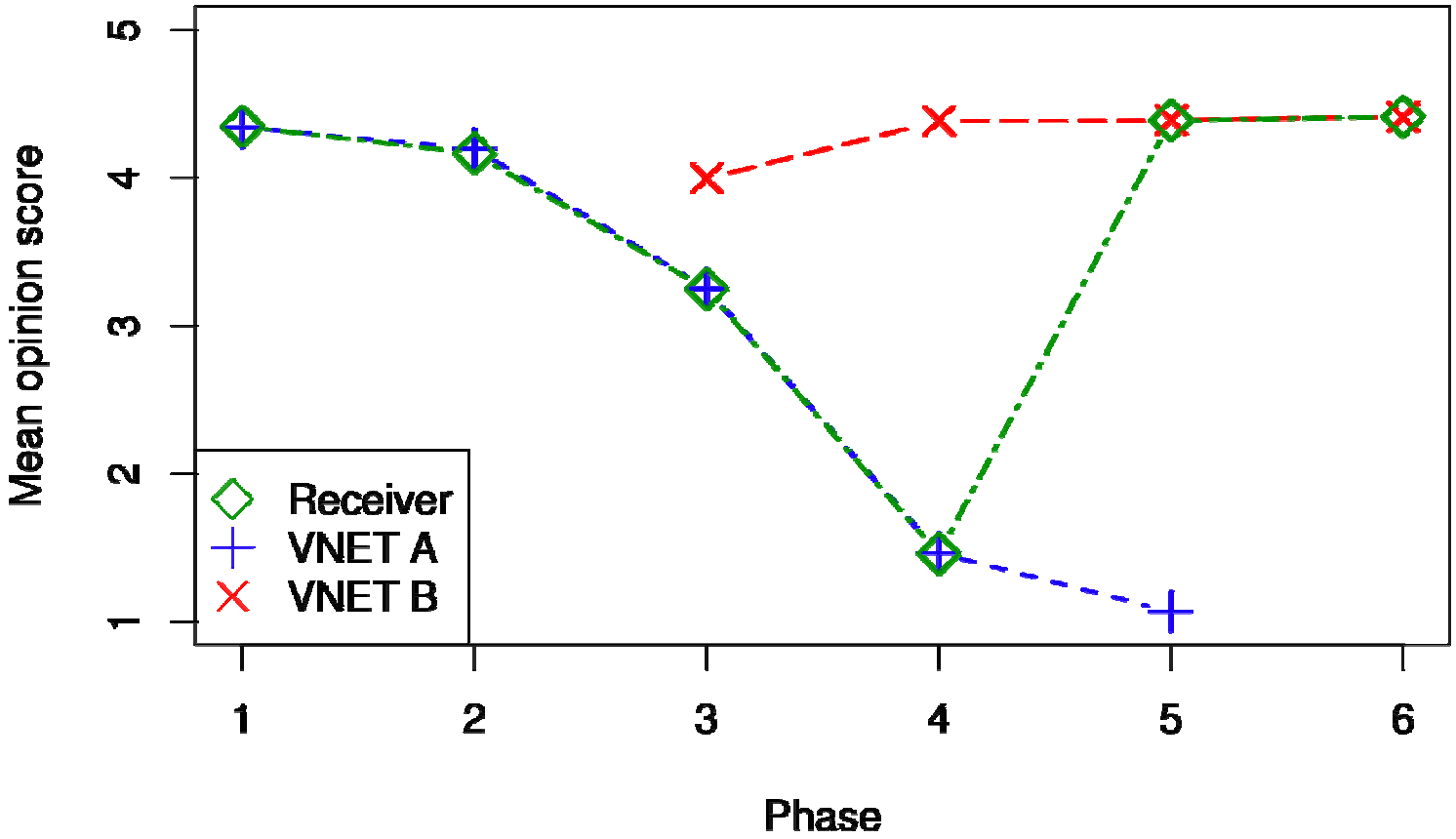


- User perceived quality is restored when the ShadowVNet is activated

# Lessons learned

- New network debugging features
  - Instrumentation
  - Testing
  - (Distributed debugger)
- Goals
  - To **not change** network under test
  - Avoid **probe effect**
- Solution: Network virtualization
  - **Isolation**
  - **Resource accounting**