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Network Troubleshooting with Mirror VNets

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Troubleshooting and **evolving**
large scale networks is still an open problem

What's a large scale network?

- Distributed system
  - Runs for a *long time*
  - State distributed in many hosts + routers
  - Under *autonomous control*
  - *Lots of users* affected
- Distributed software + configuration

Admin challenges

- Routing optimization
  - *Re-convergence can take time*
- Upgrade of faulty service component
  - E.g., upgrade the super-node software in a telephony overlay

How to avoid new bugs /
ensure smooth upgrades?

Validation

How do you test an update to the configuration or software of your system?

simulation

testbed

Simulation

simulation

✓ scalable

✓ cheap

◉ accuracy?
(wireless anyone!?)

Testbed

testbed

- ✓ *may* be more accurate
  - ◉ but user behavior?
- ◉ expensive to run
  - ◉ on large scale?
  - ◉ longtime?

Problems are nasty

They like to surface in
large scale, long term
deployments with
real user behavior/traffic.

➡ cannot be caught in small testbeds

Our approach

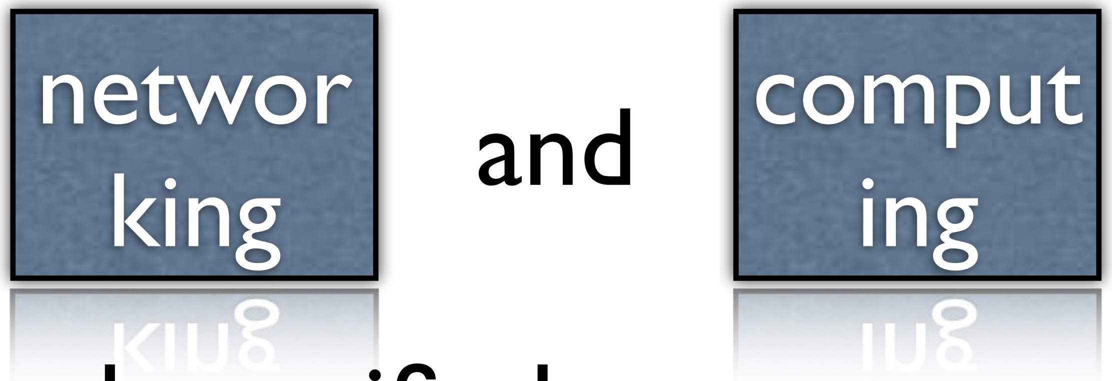
leverage **Virtual Networks**

What is virtualization?

- **Abstraction concept**
  - Hides the details of what's underneath
  - Provides layer of indirection
- Enables **Resource Sharing**
- More than **multiplexing**! -- provides
  - Isolation
  - Transparence

Virtual Networks (VNets)

combination of



networking

and

computing

under unified management

Virtual Networks (VNets)

combination of

networking and computing

slices (*slithers?*) of

routers

links

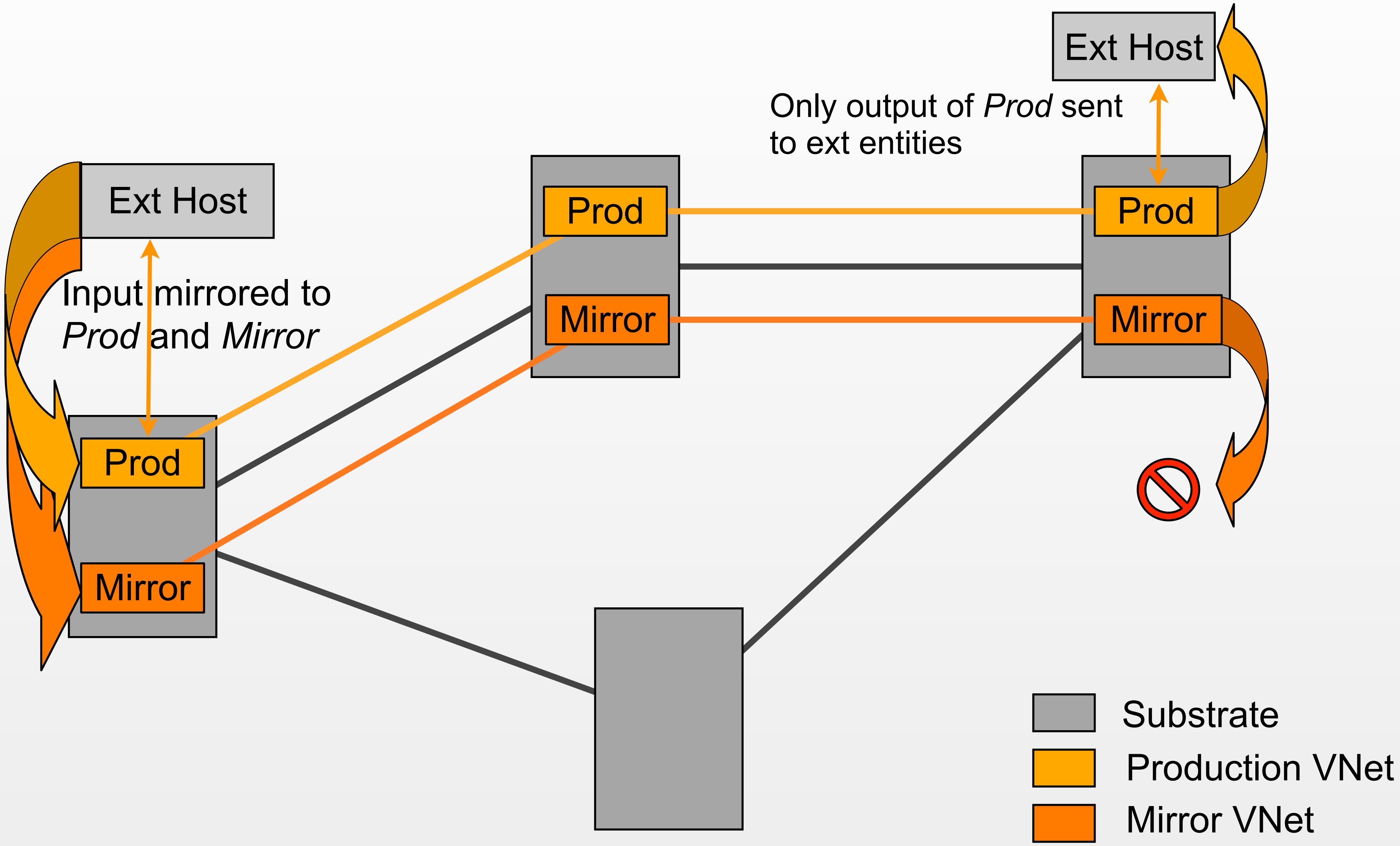
servers

end hosts

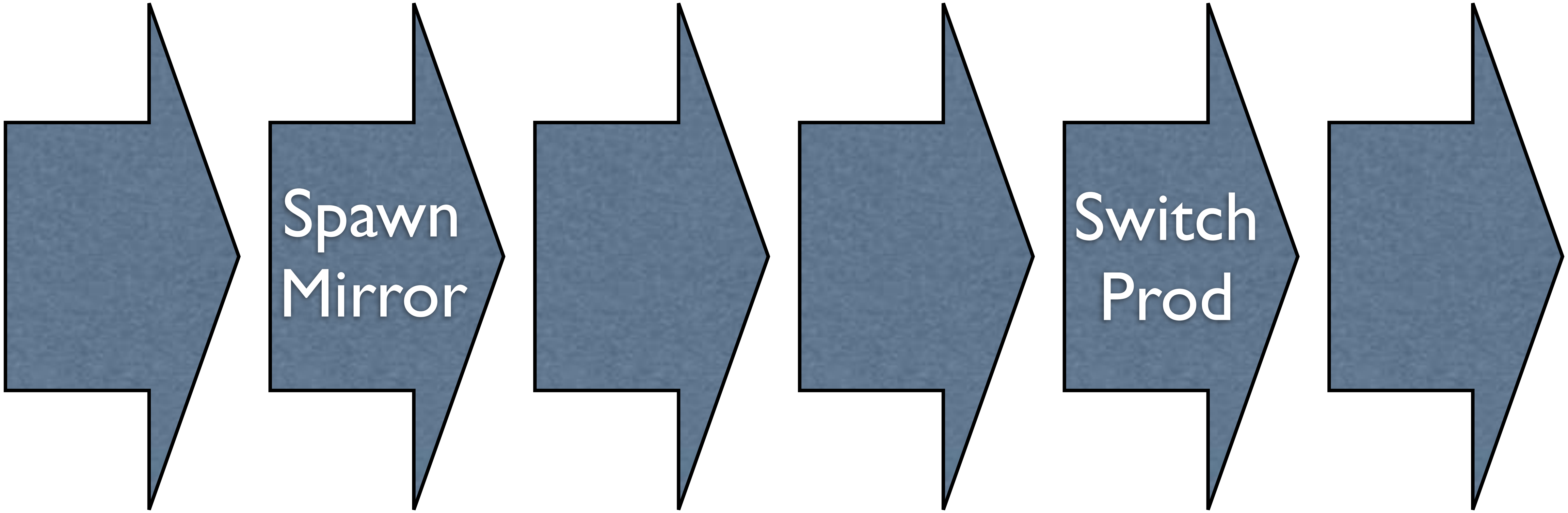
Network Virtualization

- Provides coherent view and management of **Virtual Networks (VNet)**
- Allows to run multiple **VNets**
  - On **shared substrate**
  - Under separate administrative control
  - In **isolation**

Mirror VNets



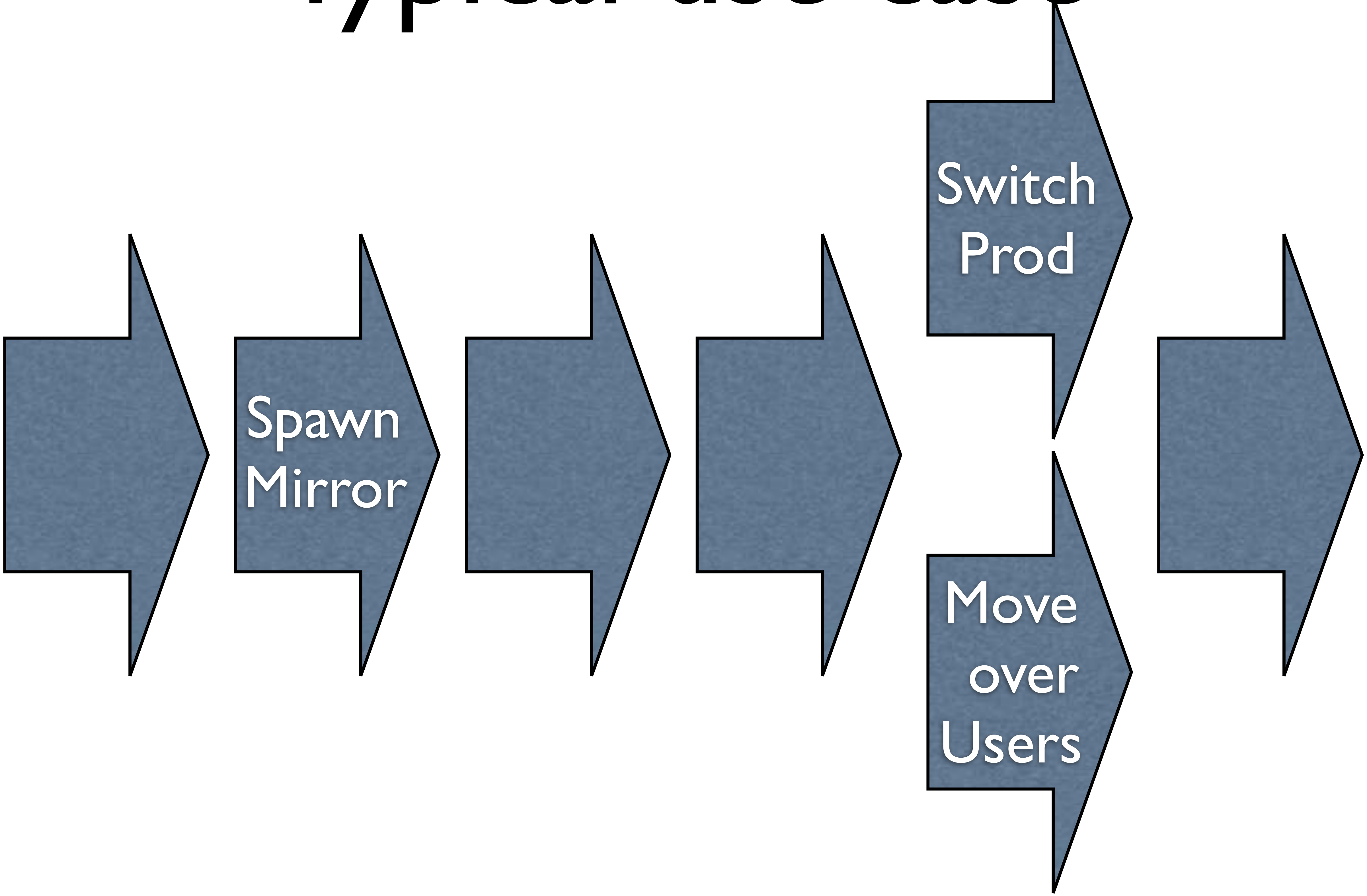
Typical use case



Spawn Mirror

Switch Prod

Typical use case



Mirroring options

Not all traffic has to be mirrored

Not all mirrored traffic has to be transmitted

Control plane traffic:
<1% of data volume
>90% bugs

Mirroring options

Reducing Mirroring

- All traffic
- Selection
  (OF Rules, Layer 1-4)
- Sampling

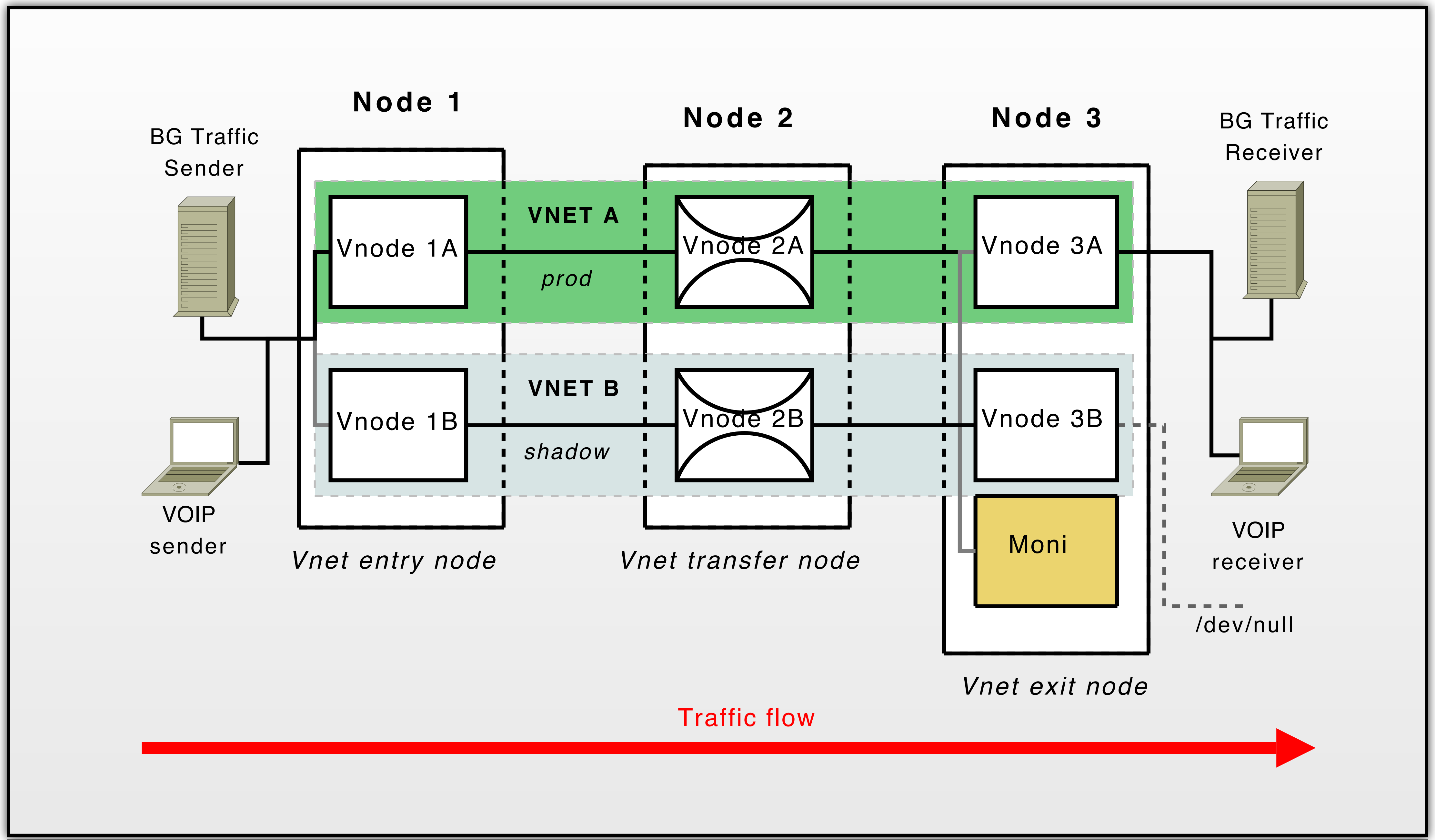
Reducing Transmission

- Full Transmission
- Packet Headers
- Re-synthesized based on stats

Mirror VNet case study

- Operator considers introduction of QoS because of customer complaints of lacking quality at peak load
- Uses a Mirror VNet to test solution, then switch over

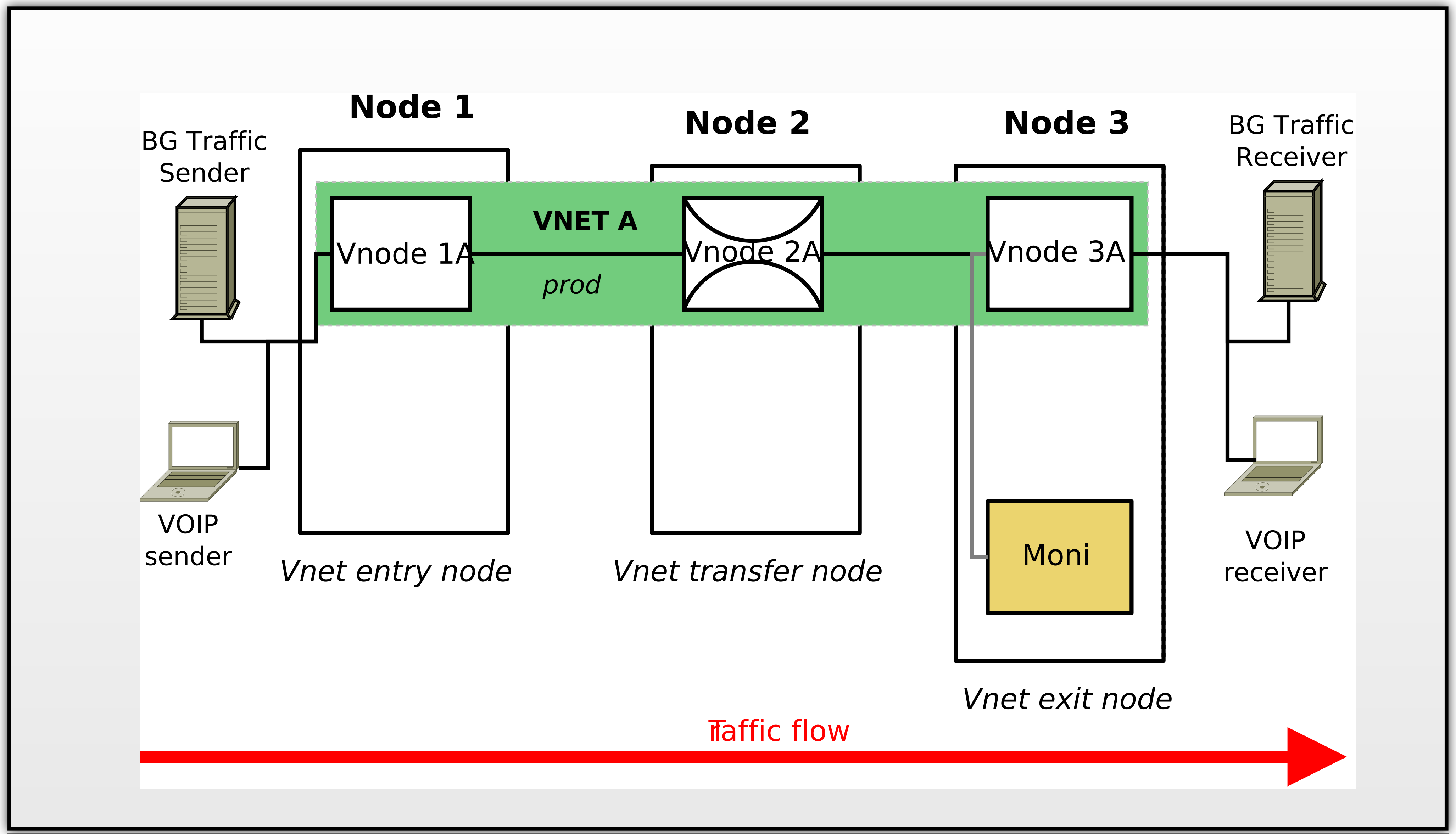
Experiment setup



Metrics

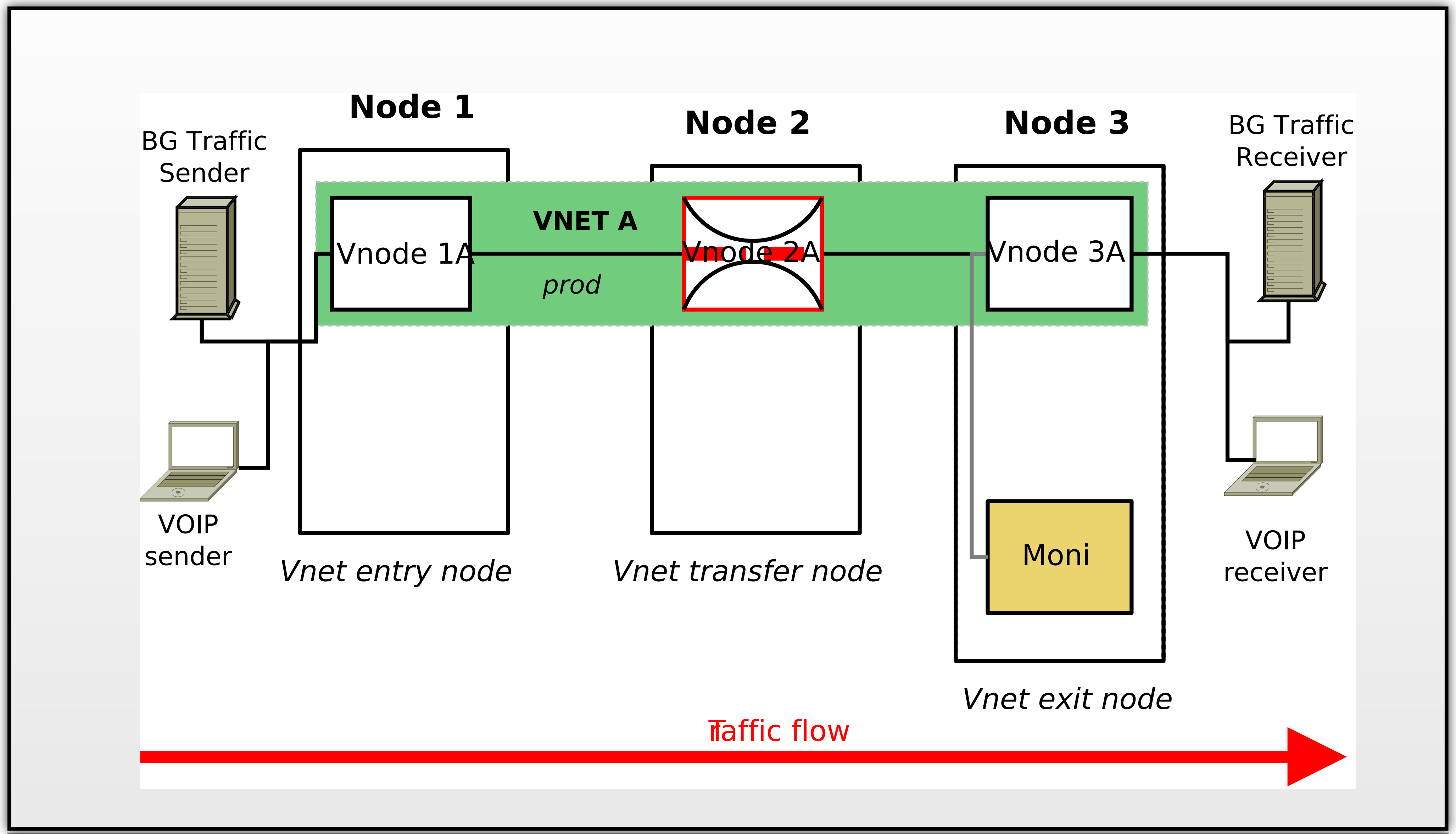
- VOIP packet drops
- MoS: Mean Opinion Score
  - using ITU-T E-Model
  - non linear Quality Of Experience Metric
  - values from 1 (worst) to 5 (best)

Experiment phases



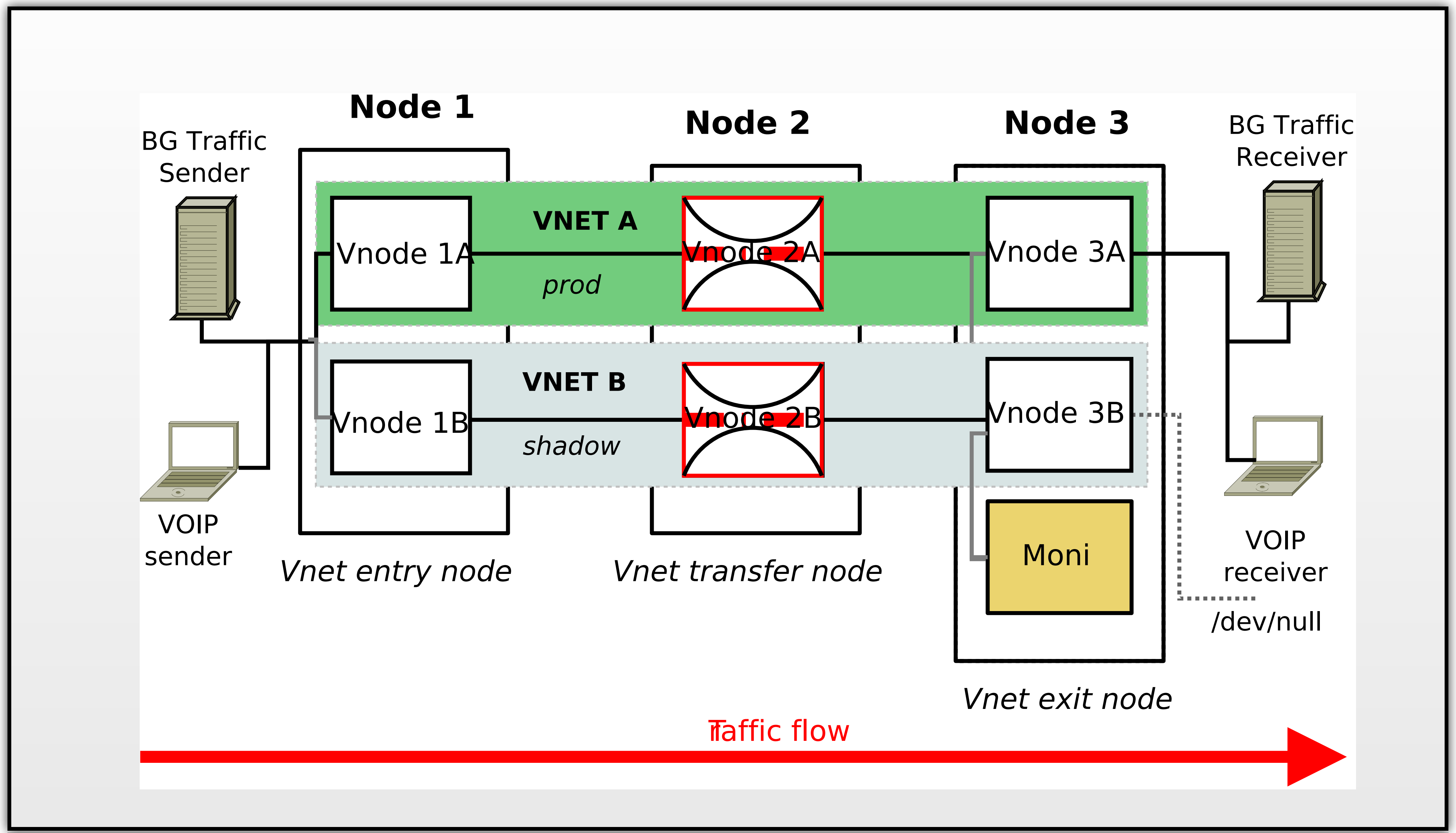
Phase 1: Things are running smoothly

Experiment phases



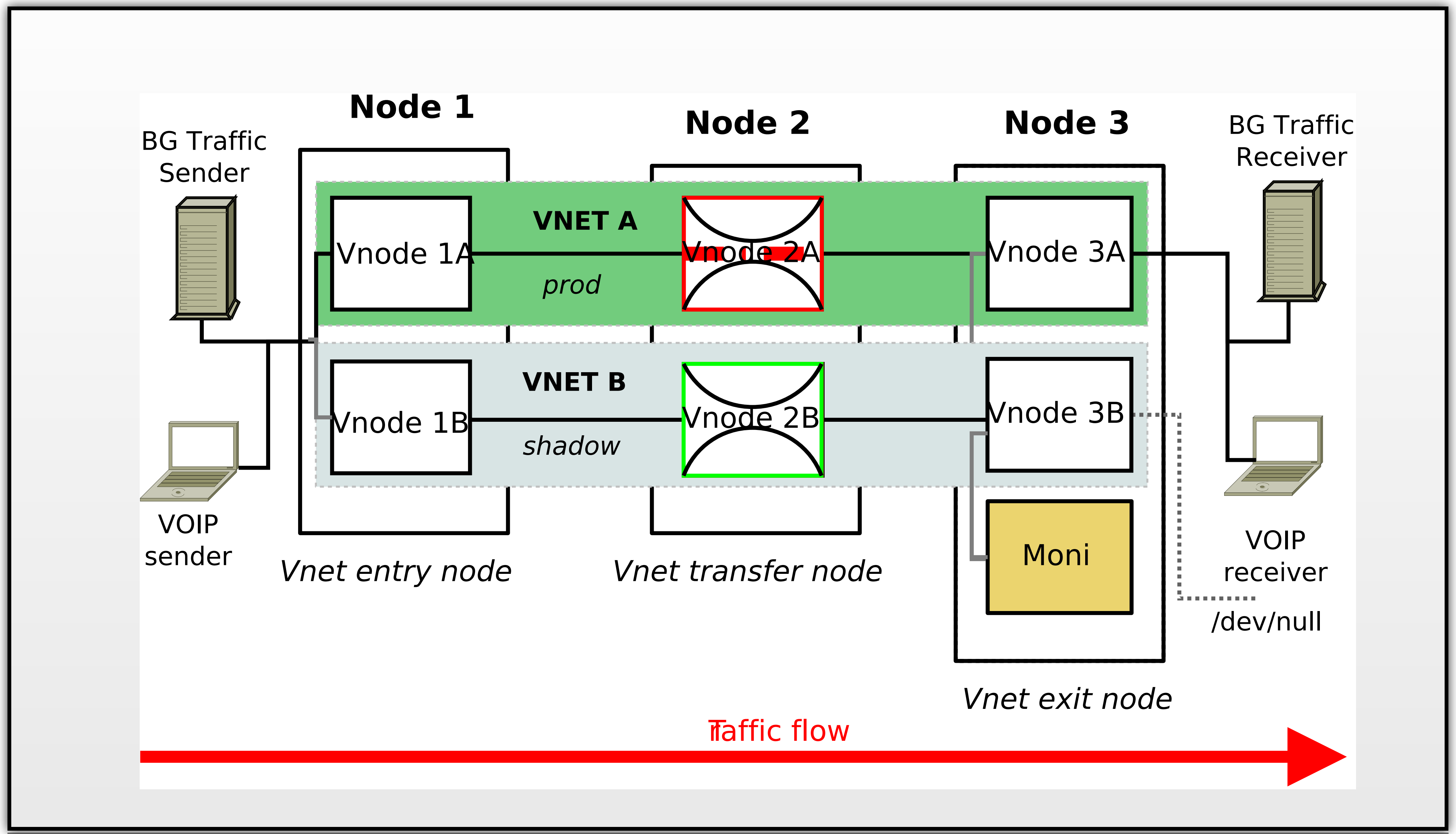
Phase 2: Traffic spikes cause overload in VNode 2, quality degradation

Experiment phases



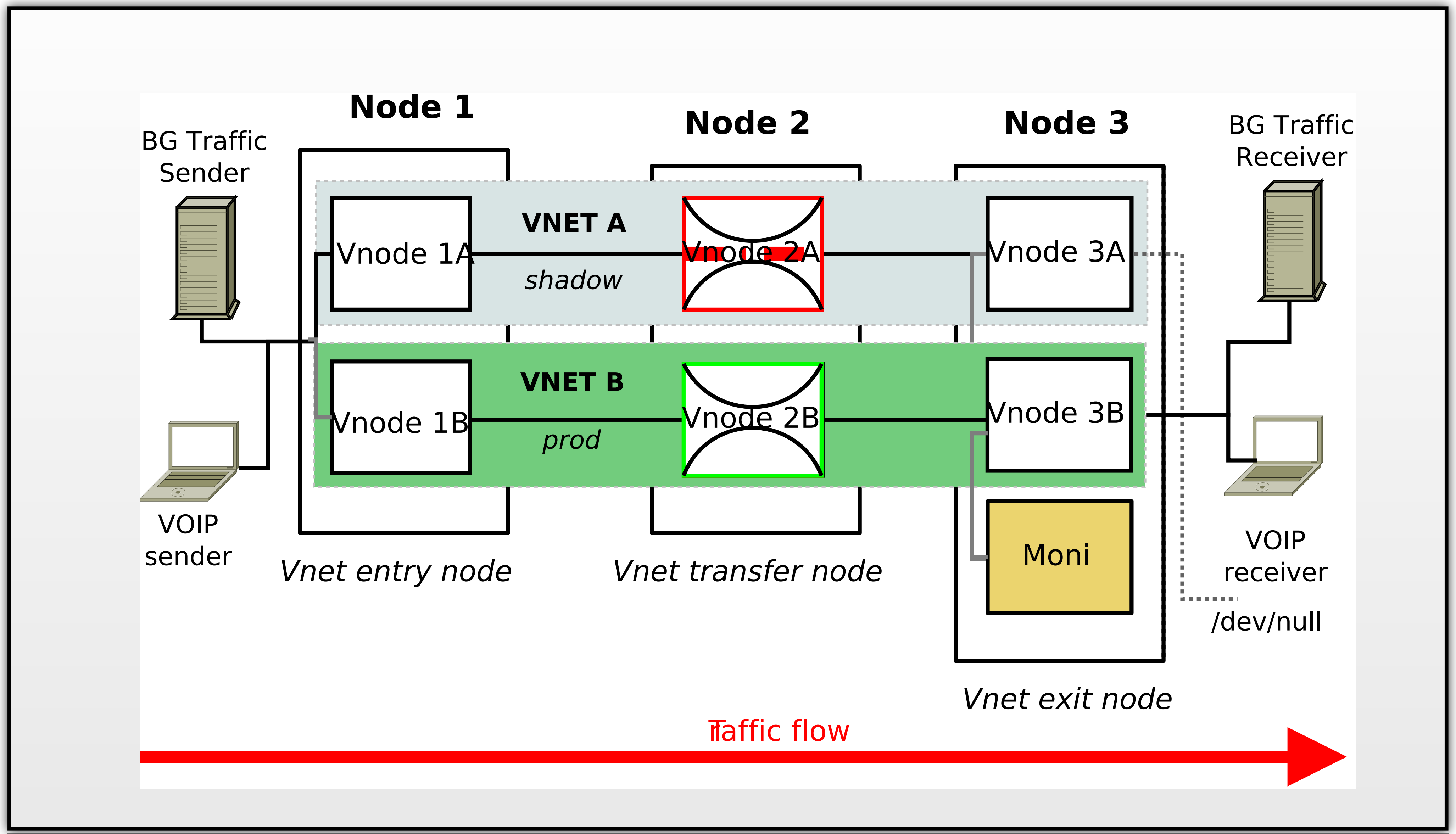
Phase 3: Operator introduces Mirror VNet

Experiment phases



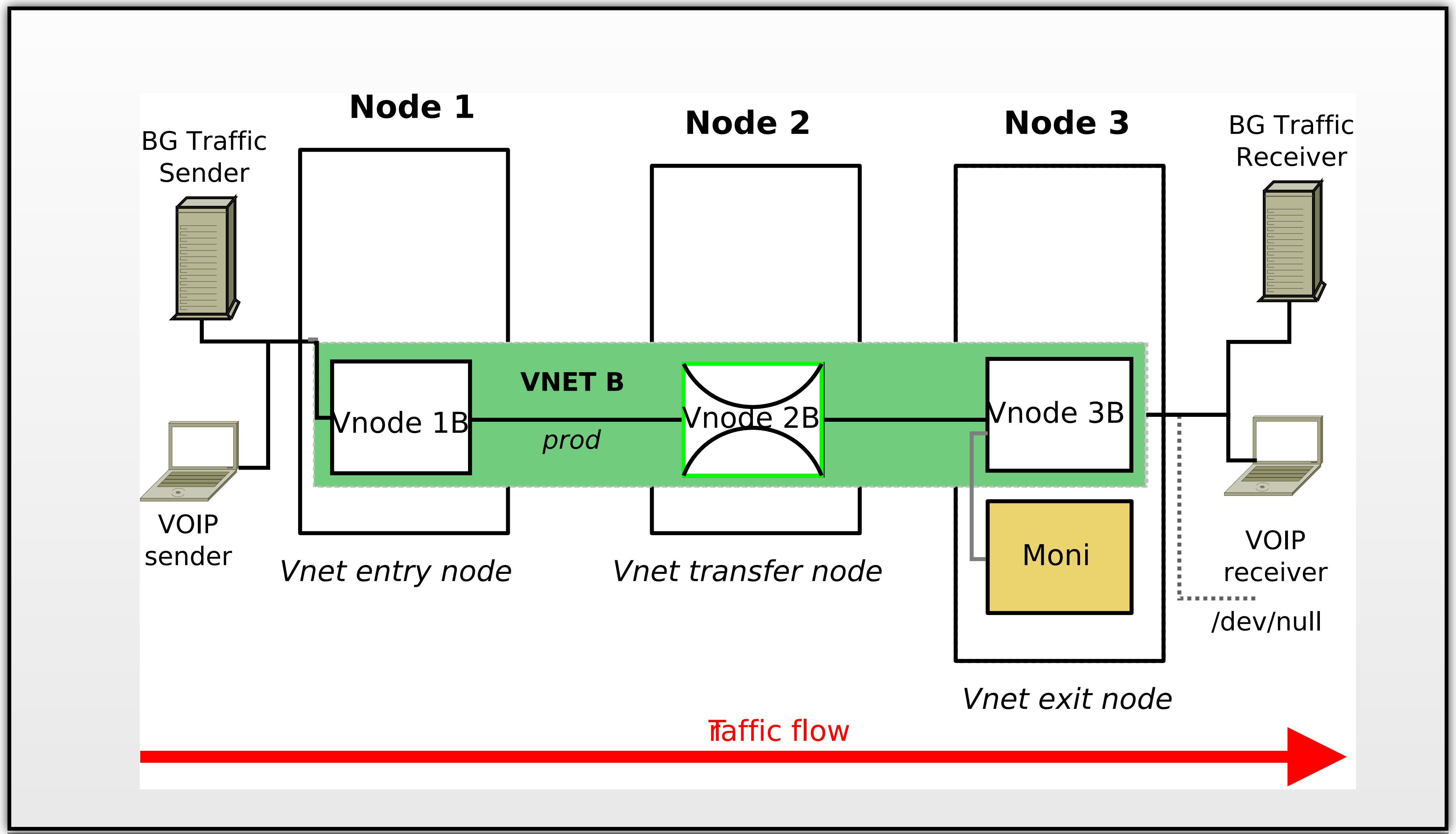
Phase 4: Operator fixes problem in Mirror (introduces QoS)

Experiment phases



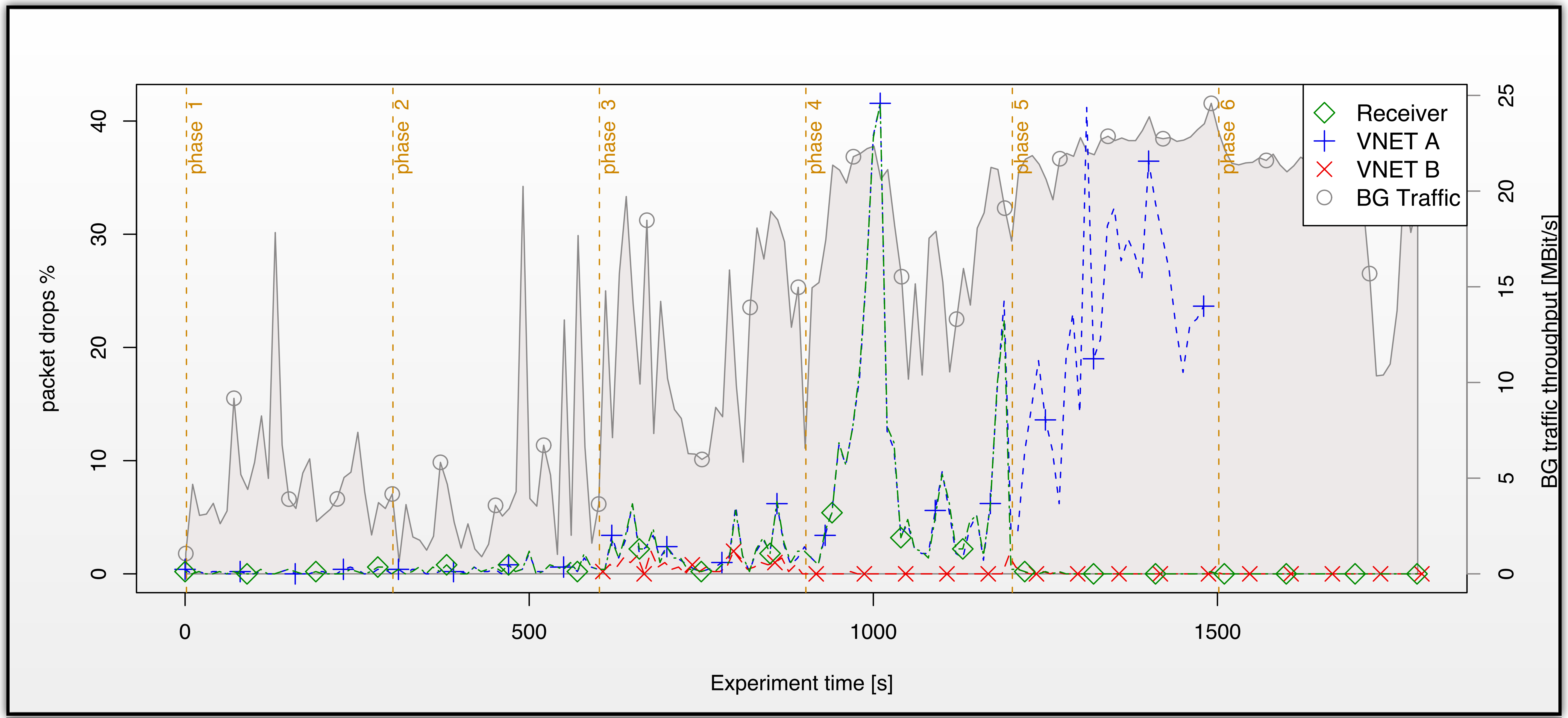
Phase 5: Operator switches VNets

Experiment phases

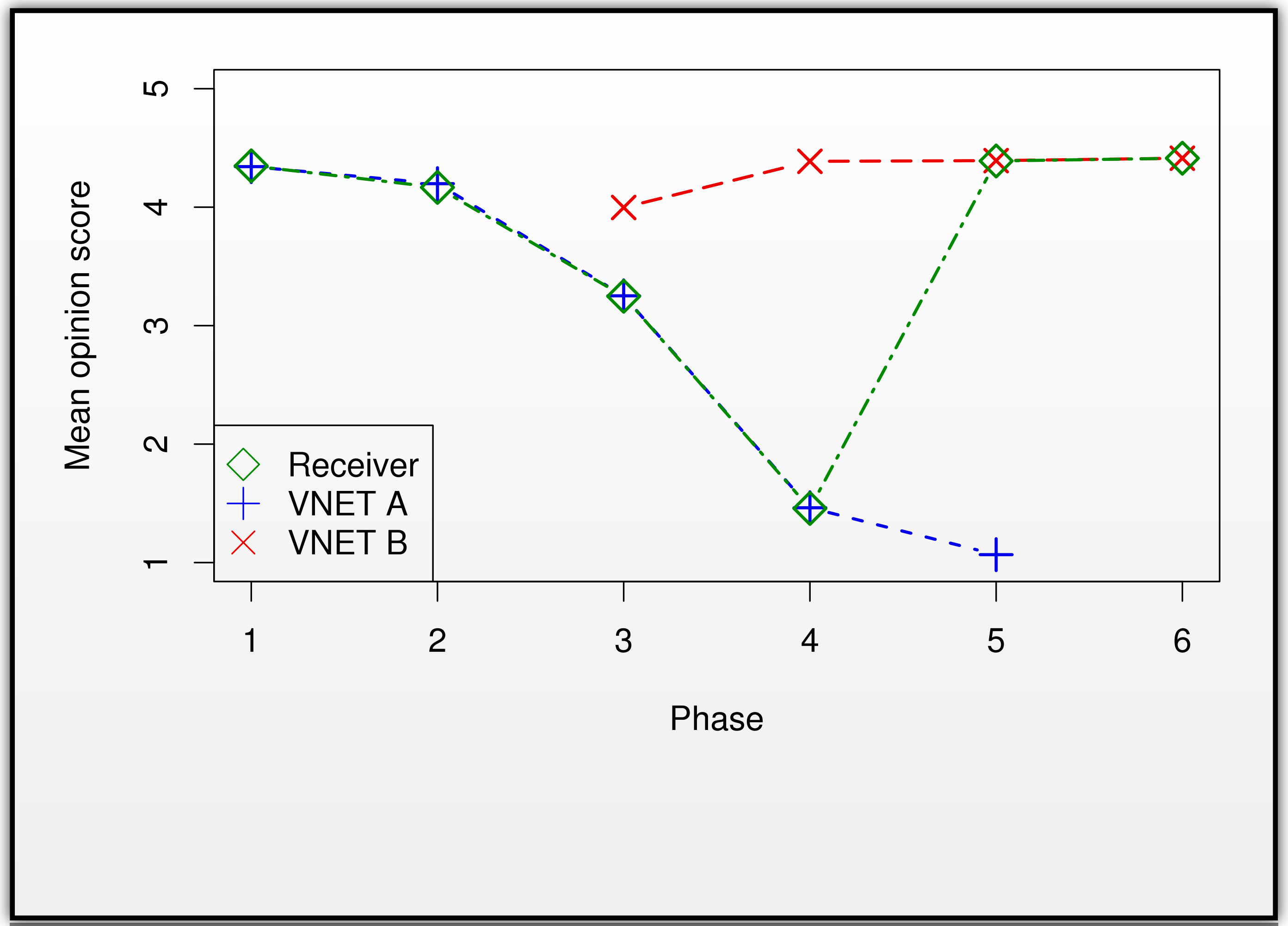


Phase 6: Operator dismantles VNET A

Experiment results (1)



Experiment results (2)



Phases

1 low traffic

2 high traffic

3 start Mirror VNET B

4 enable QOS

5 make VNET B prod.

6 dismantle A

Discussion

- Benefits
  - Resilience against operator mistakes
  - Real user traffic
  - Rollback / undo for networks

Discussion

- Limitations
  - Trade-off between overhead and prediction
  - Elastic/closed loop traffic limits prediction quality

Future work

- Further case studies, larger networks
- Predict elasticity of traffic, adapt mirror predictions

Thank you.