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Authenticated Setup of Virtual Links with Quality-of-Service Guarantees

Roland Bless, Martin Röhricht, Christoph Werle
Institute of Telematics, Karlsruhe Institute of Technology (KIT)

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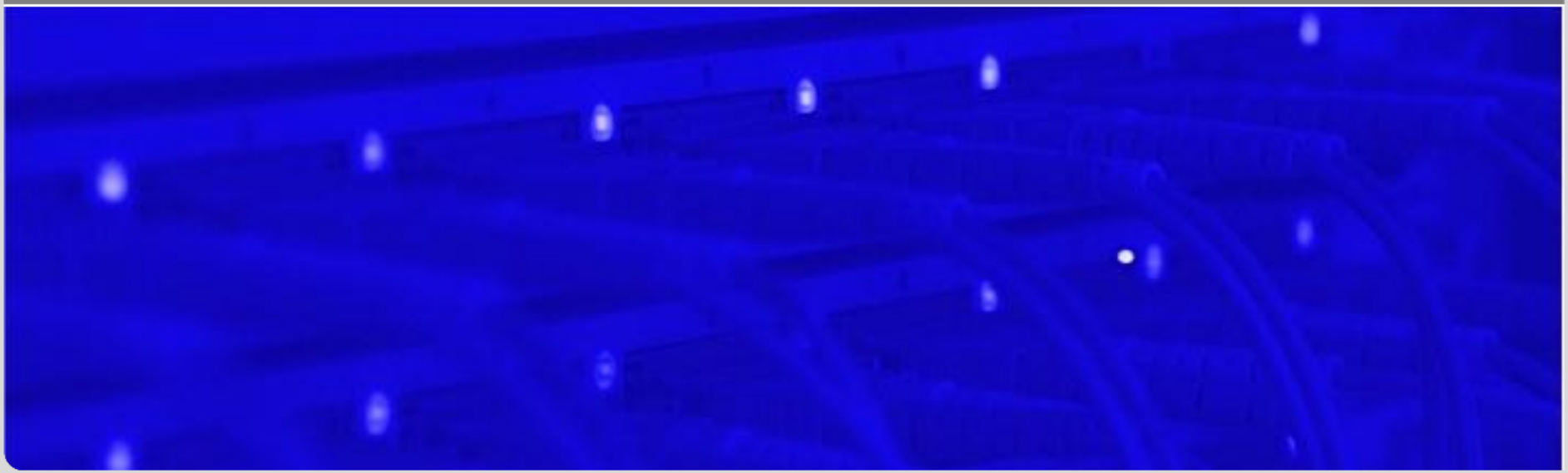
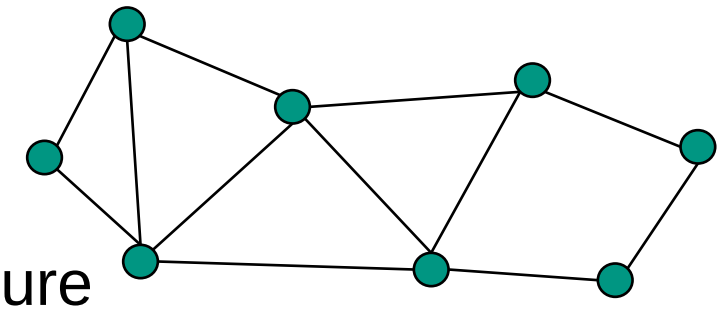


Motivation

- Network Virtualization is an enabling technology
- Easier deployment of global networks and services
  - Homogeneity across provider domain boundaries
- Parallel operation of different network architectures
  - deploy novel network architectures and E2E services without requiring Internet-wide consensus
- Increased flexibility
  - On-Demand creation and modification of virtual network topology and resources, esp. nodes and links
  - Resource migration as Traffic Engineering mechanism
  - More efficient use of resources (exploit statistical multiplexing gain)

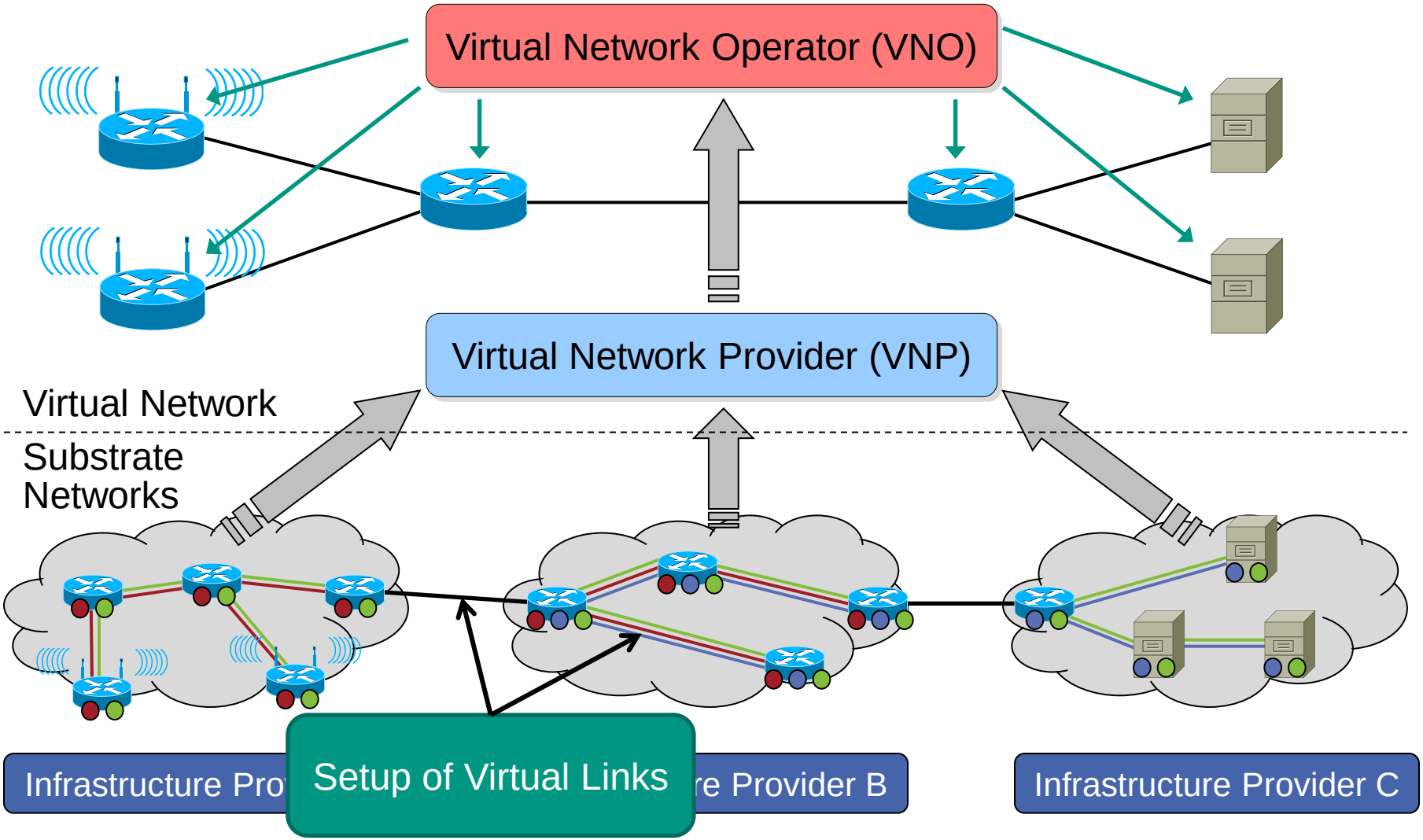
Network Virtualization

- Virtual Network (VNet)
  - Set of (virtual) nodes directly connected by (virtual) links (realized on top of a set of physical resources, the “substrate”)
  - „Naked“ topology at layer 3
  - No assumptions about the network protocols or architecture running inside the VNet, i.e., not necessarily IP



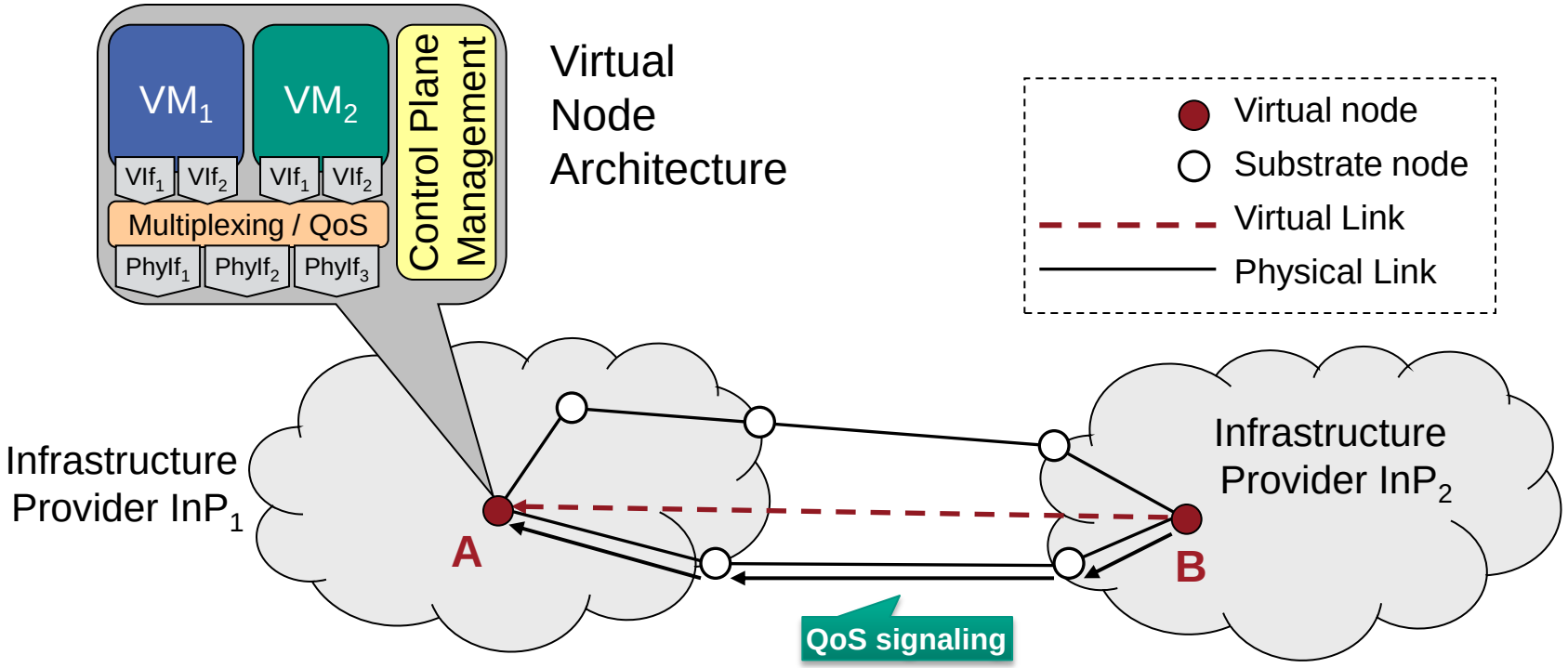
  - May use various substrate techniques to create virtual links, e.g., IP Tunnels, MPLS, Ethernet VLANs,…
  - We assume an IP-based substrate
- Partitioning or aggregation of resources possible

Network Virtualization Business Model



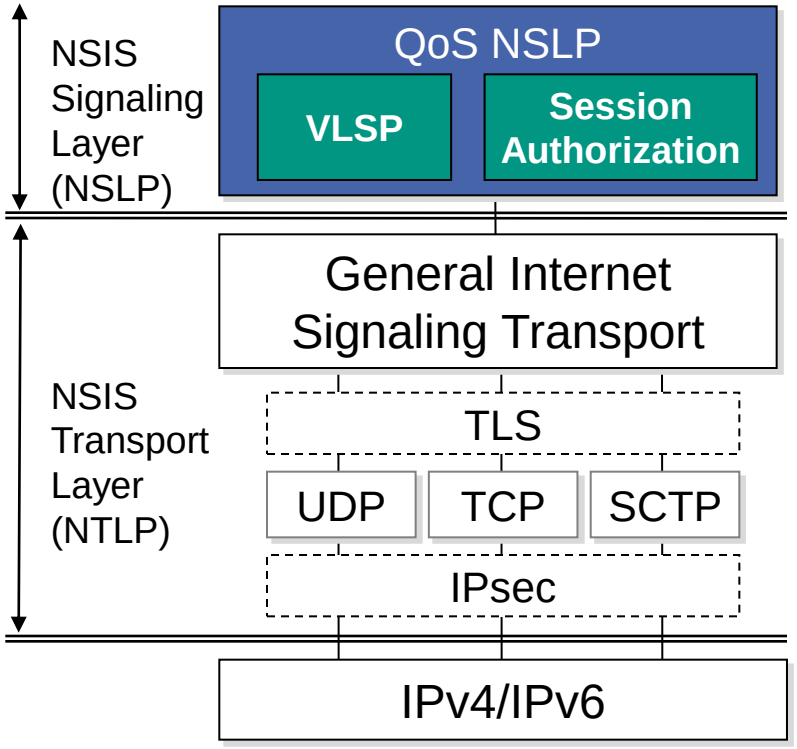
Setup of Virtual Links with QoS

- Isolation and QoS guarantees required
  - need to reserve resources along a substrate path
- Combine resource reservation with virtual link setup

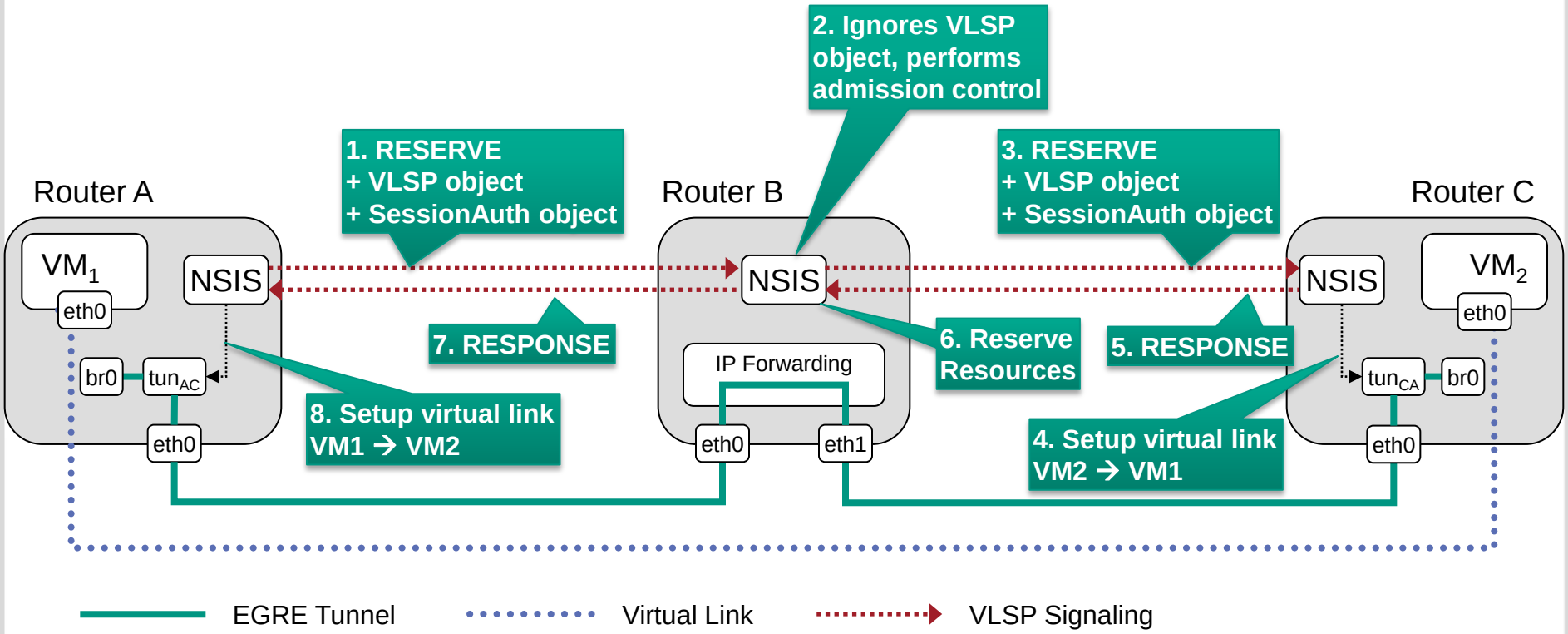


Approach

- Use existing QoS resource reservation protocol of the NSIS framework QoS NSLP
- Need interoperable solution for link setup across provider (InP) domains
- Add information object for setup of virtual links
- Add security object
  - Authentication (Pre-Shared Key)
  - Integrity protection for NSLP msgs (HMAC)

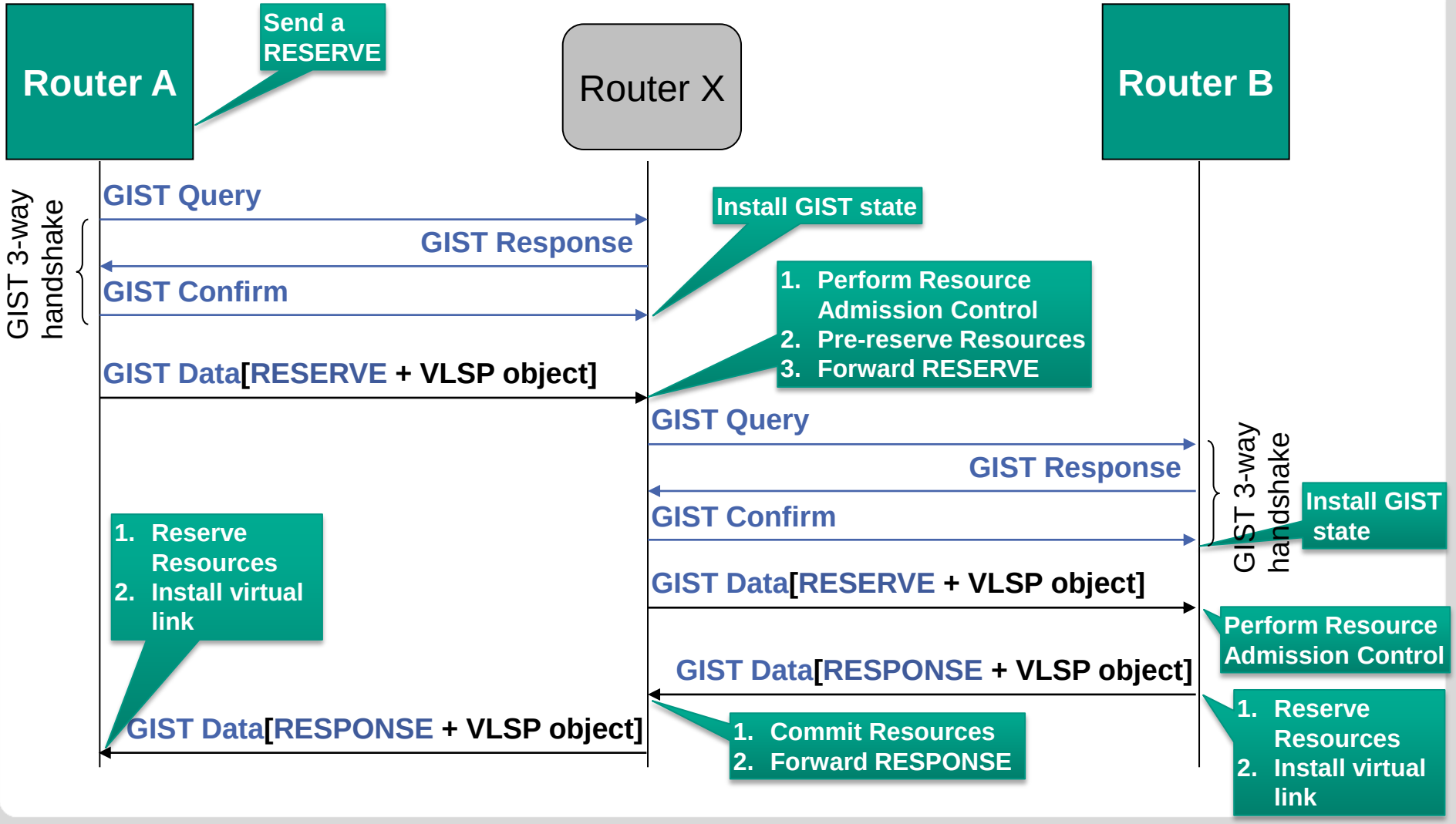


Step by Step Example



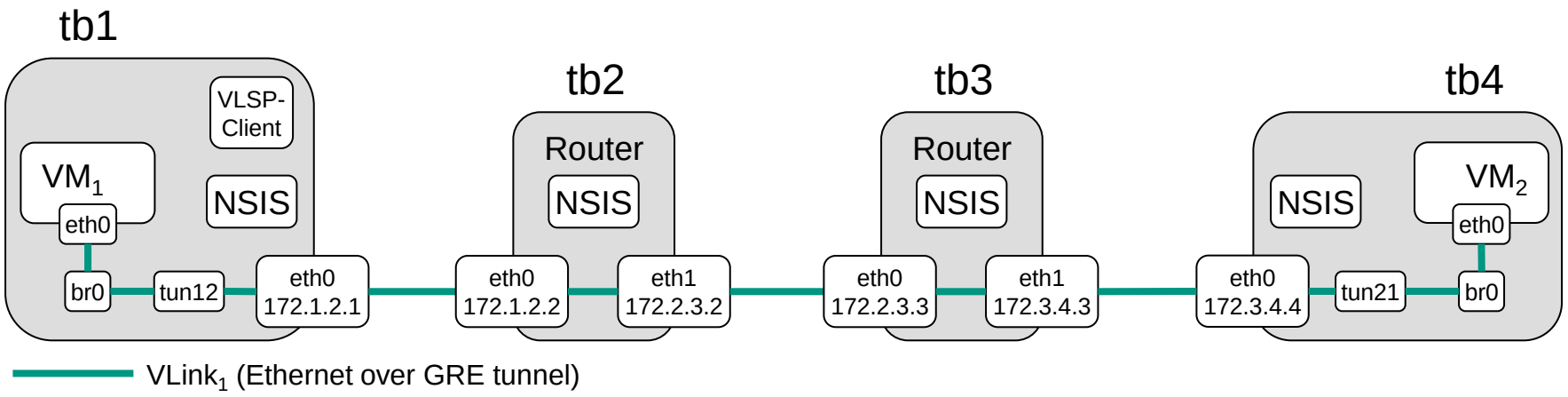
- Shows unidirectional resource reservation VM1→2
- Bidirectional reservation is possible

Detailed Message Sequence with GIST



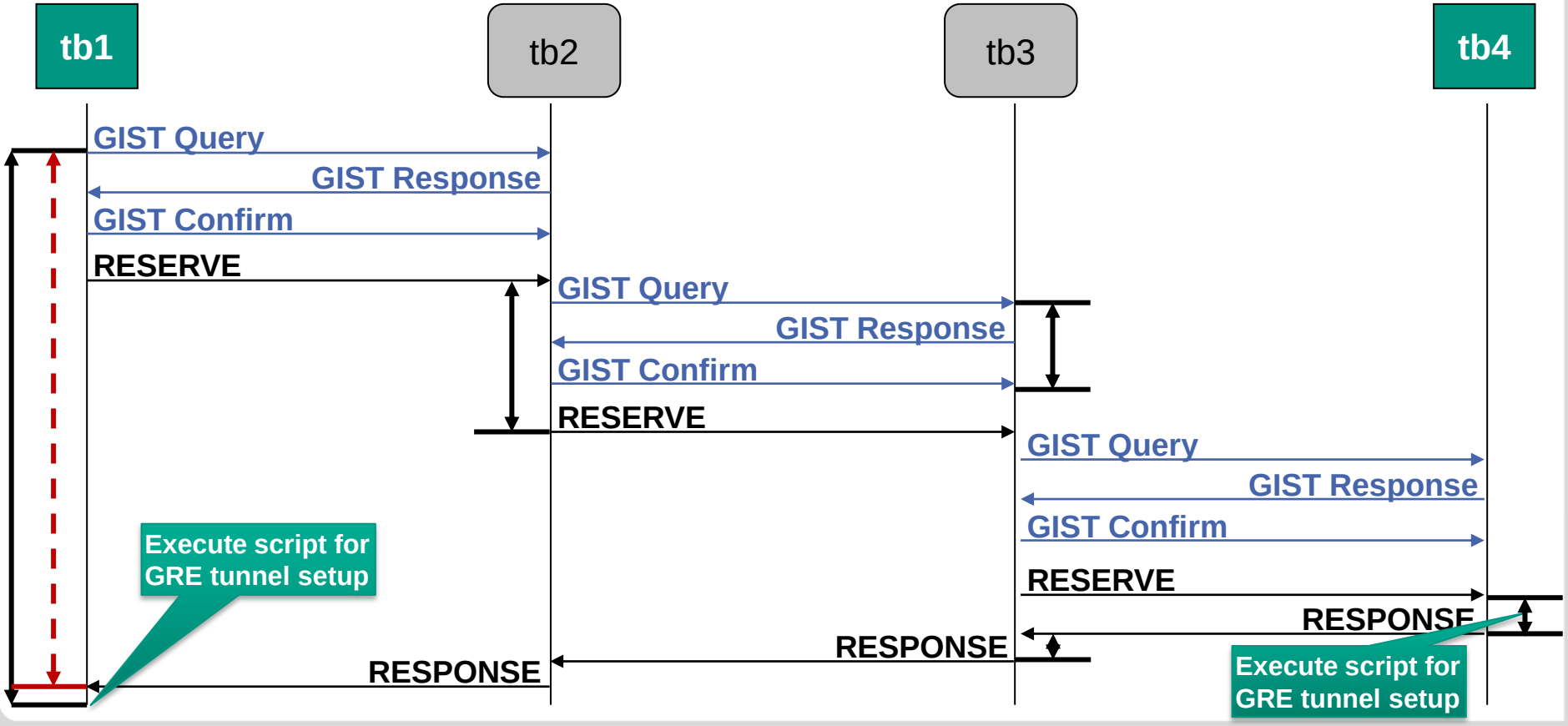
Evaluation Setup

- How long does it take to setup a virtual link, incl. QoS guarantees?
- Used freely available NSIS implementation (C++) http://nsis-ka.org/ → evaluation code is available!
- Linux, KVM-based VM, Xeon X3430 Quad-core@2.4GHz, GRE Tunnel

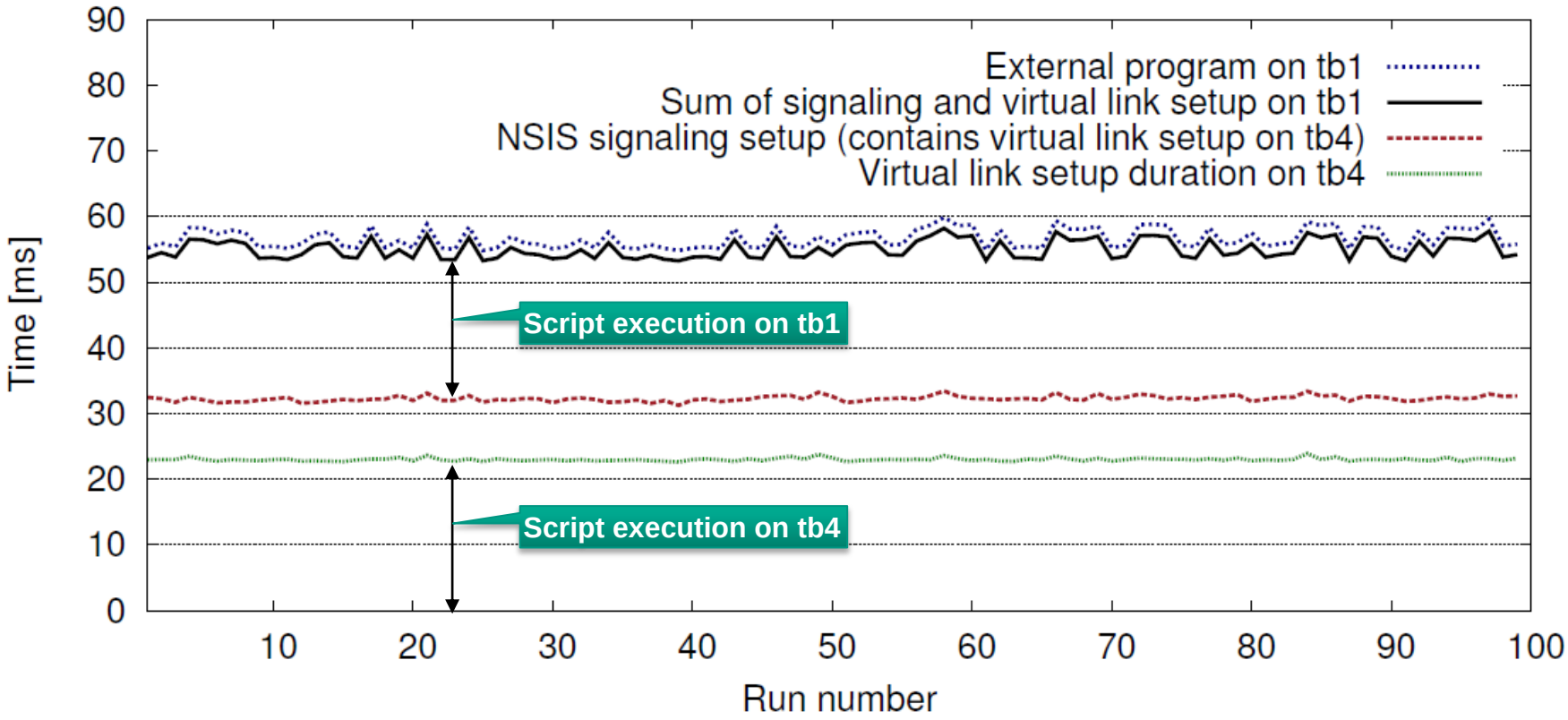


Measurement Methodology

- Measurement points in the code
- tcpdump packet capture on all nodes tb1 – tb4

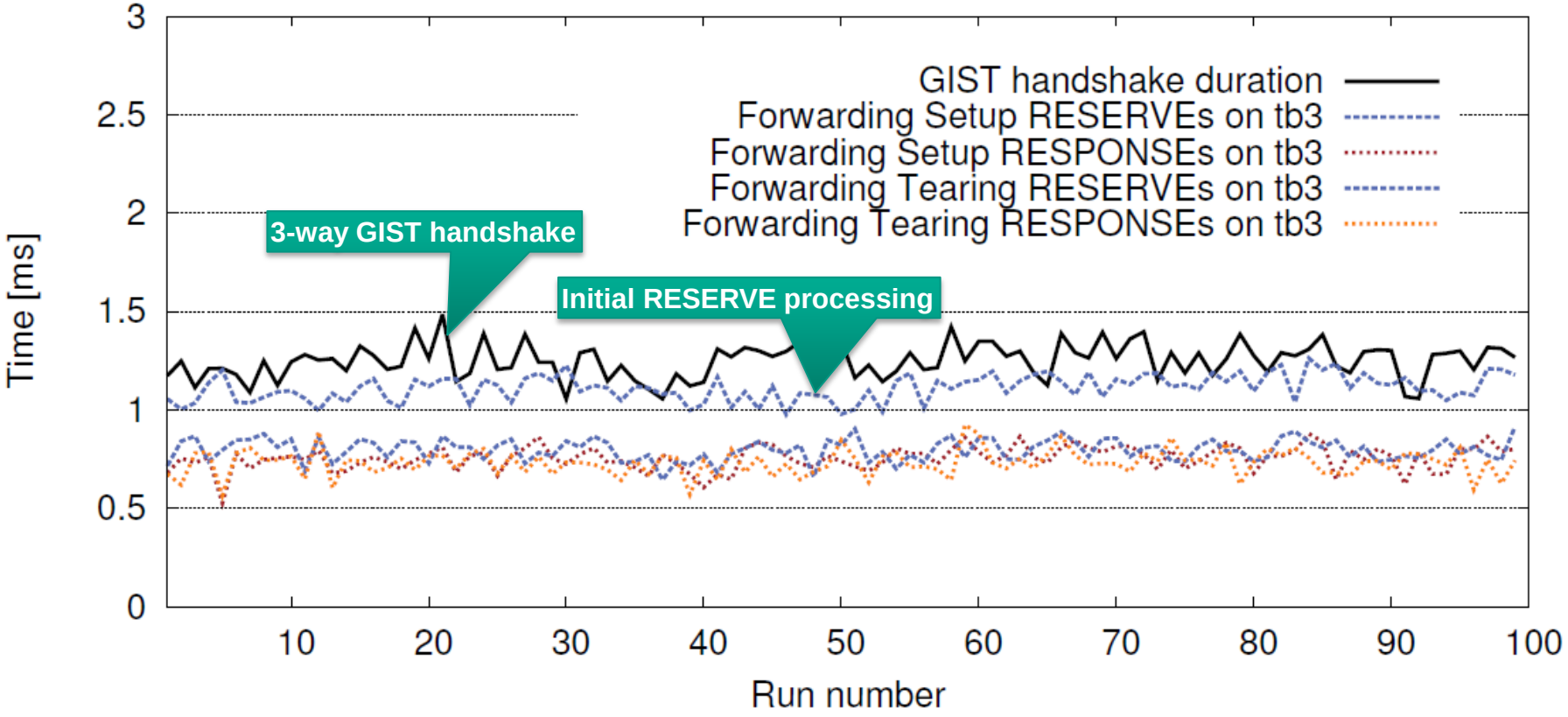


Total Duration



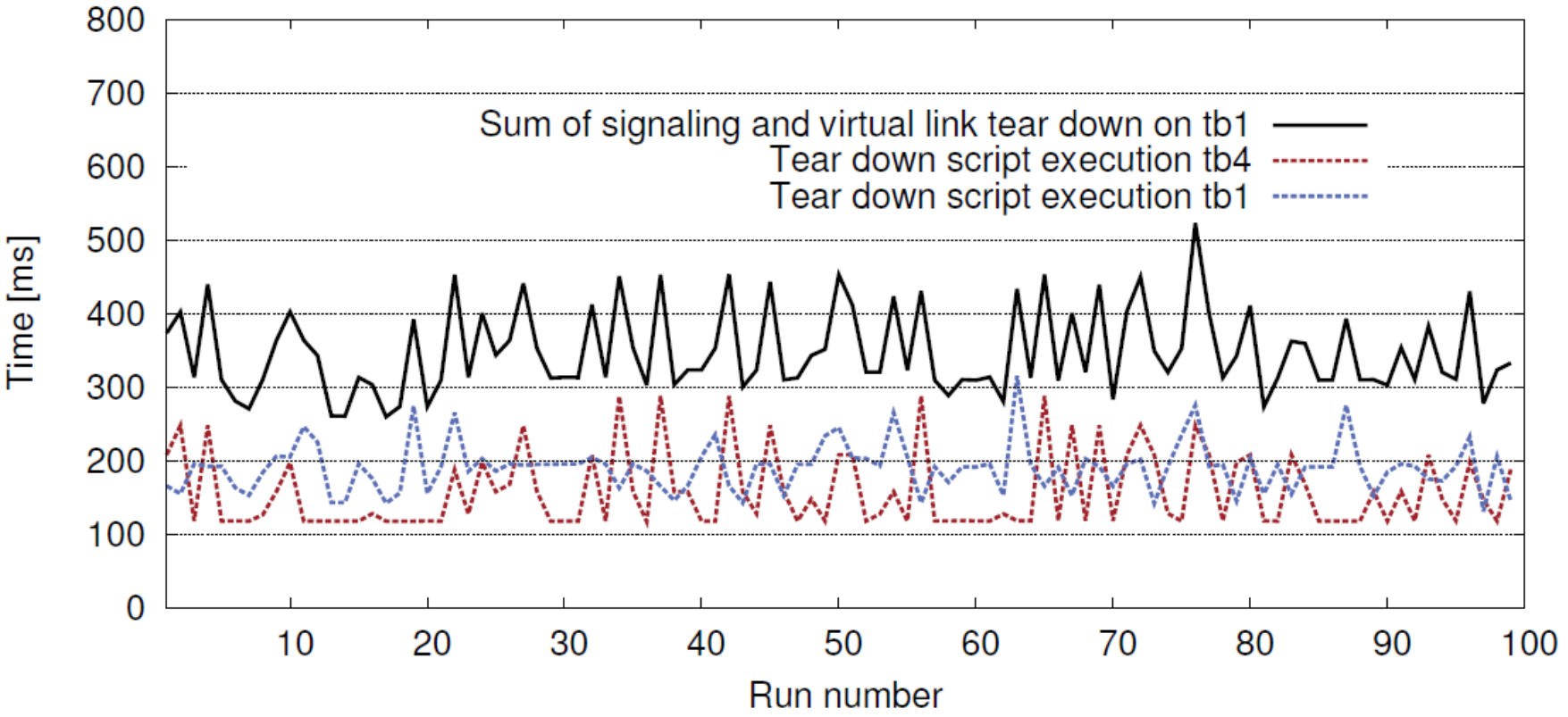
- Round-trip time tb1→tb4: 0.7ms
- External program triggers virtual link setup
  - Includes inter-process communication
- Script execution for virtual link setup dominates

Pure NSIS Signaling



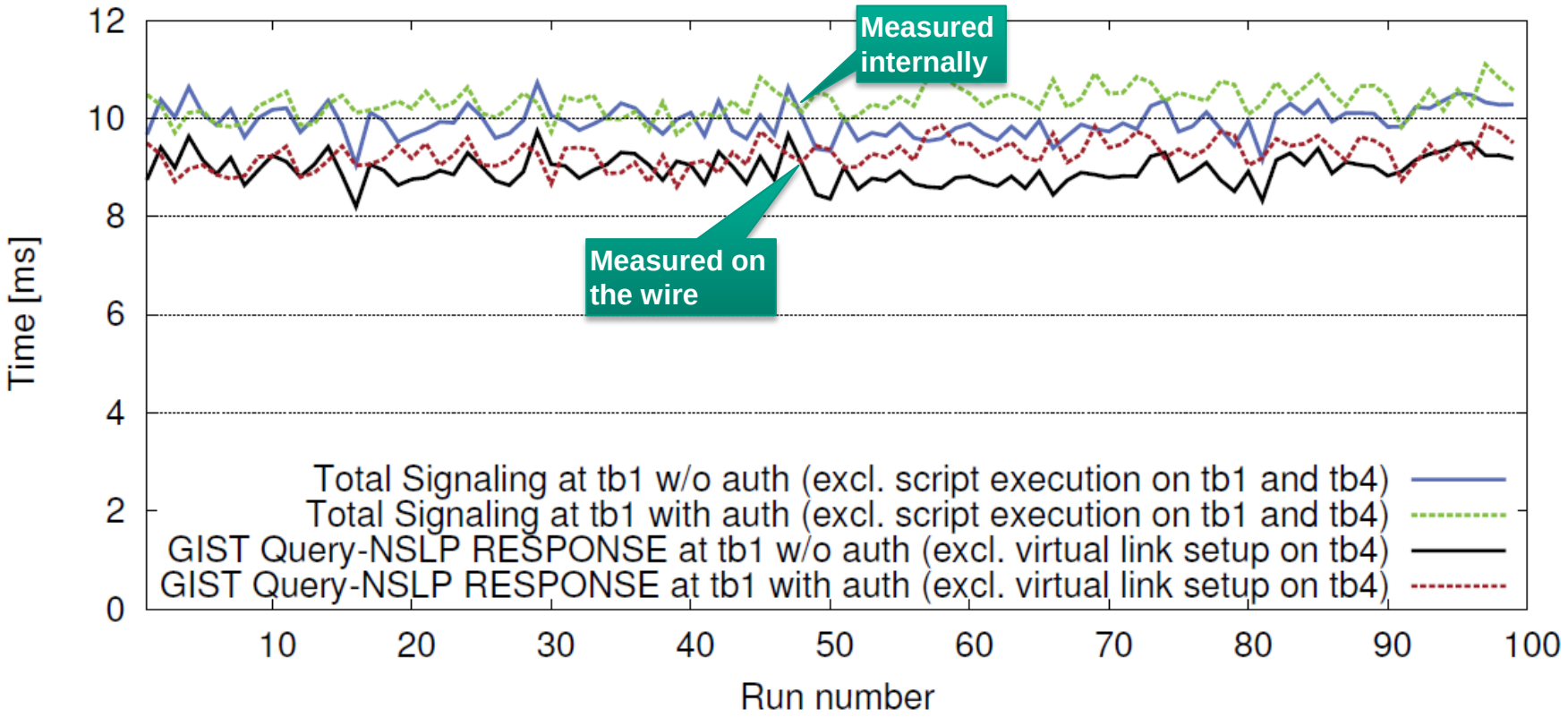
- Intermediate node processing <1ms

Teardown Duration



- Link teardown takes much longer than setup, presumably due to “still in-use” checks
- Teardown not so critical (compared to setup)

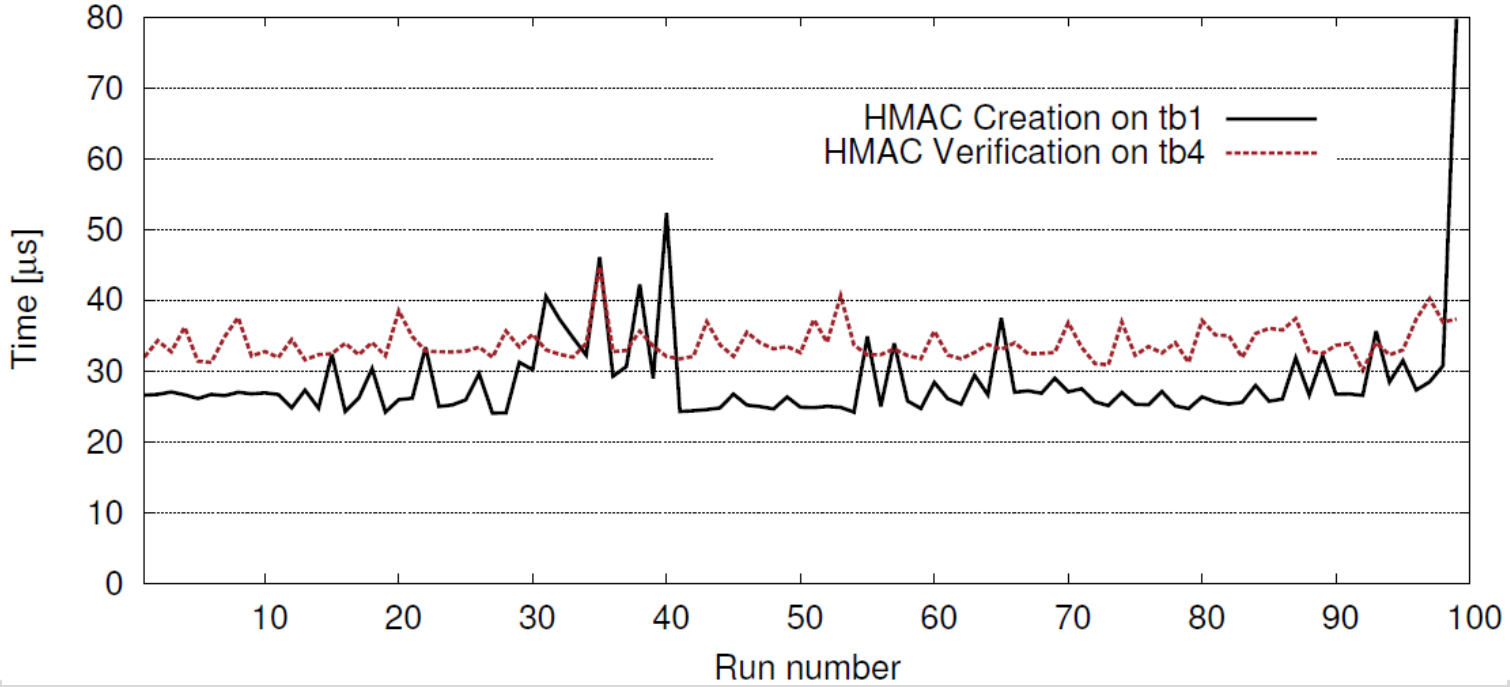
Signaling Authentication Overhead



- Subtracted script execution for virtual link setup
- No significant overhead if security is used

Authentication Overhead

- Additional SessionAuthorization object [RFC5981]
  - Protects RESERVE and RESPONSE messages
  - Added 104 bytes to message (VLSP object: 80 bytes)
- HMAC calculation is negligible



Conclusion and Summary

- Combining QoS reservation and virtual link setup is useful and efficient
- Extension of an existing NSIS signaling protocol was easy
  - Additional VLSP object is ignored by intermediate nodes, but will perform QoS resource reservation
  - Local link setup within nodes is much more costly than pure signaling and admission control processes
- Securing the signaling is important and can be done without significant overhead
- Currently: extend approach by node setup

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Thank you!