Routed End-to-End Ethernet Network Proof of Concept

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Agenda

- Introduction
- Ethernet and IEEE 802.1 (layer 2)
- IPv4 and IPv6 (layer 3)
- RE2EE
- Proof of Concept
- Results
- Conclusions

Introduction

- Problems in the contemporary Internet
    - IPv4 address space is running out of addresses
    - Routing tables are getting oversized
- IPv6 has been implemented, but deployment is not progressing
- Something needs to be done!

Ethernet

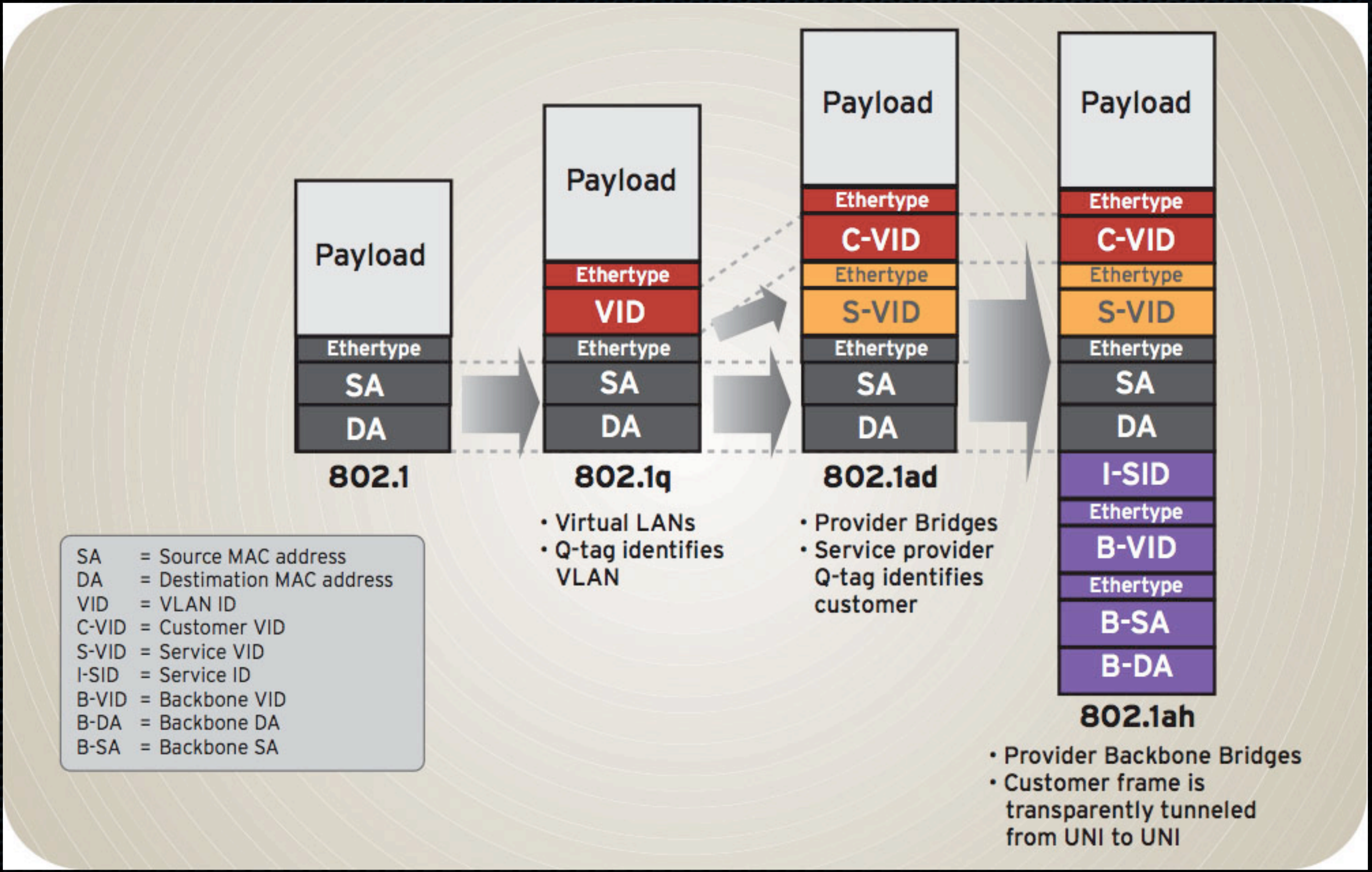
- Ethernet has a large address space with its MAC addresses
  - Not expected to be exhausted sooner than the year 2100
  - EUI-48 (MAC) could be even enlarged with EUI-64
- Ethernet is widely used and low-cost to implement
- Does not have hierarchy in addresses -> no efficient routing -> does not scale well

IEEE 802.1 (1/2)

- There are many standards and drafts to enhance the scalability of Ethernet networks
- 802.1Q - Virtual LANs
  - Q-tag adds 2nd tier to network's hierarchy
  - Inter-VLAN communication needed to be done using layer 3 routers
- 802.1ad - Provider Bridges
  - Q-in-Q added support for three-tiered hierarchy
  - Still supports only 4094 customer VLANs for ISPs

IEEE 802.1 (2/2)

- 802.1ah - Provider Backbone Bridges
  - MAC-in-MAC separates Ethernet network into customer and provider domains with complete isolation among their MAC addresses
  - It encapsulates the customer MAC header with a service provider MAC header
  - Supports a theoretical maximum of 16 million service instances
  - Still a draft and the newest version is 4.0



Development of Ethernet headers

IPv4 and IPv6

- IPv4 became the main protocol for Internet because of the hierarchical addresses, which allowed efficient routing
- Now IPv4 address space is running out of addresses
- Network Address Translation has been postponing the problem, but at the same time causing other problems
- IPv6 enlarges the address space
- IPv6 has been implemented, but deployment is not progressing

Routed End-to-End Ethernet

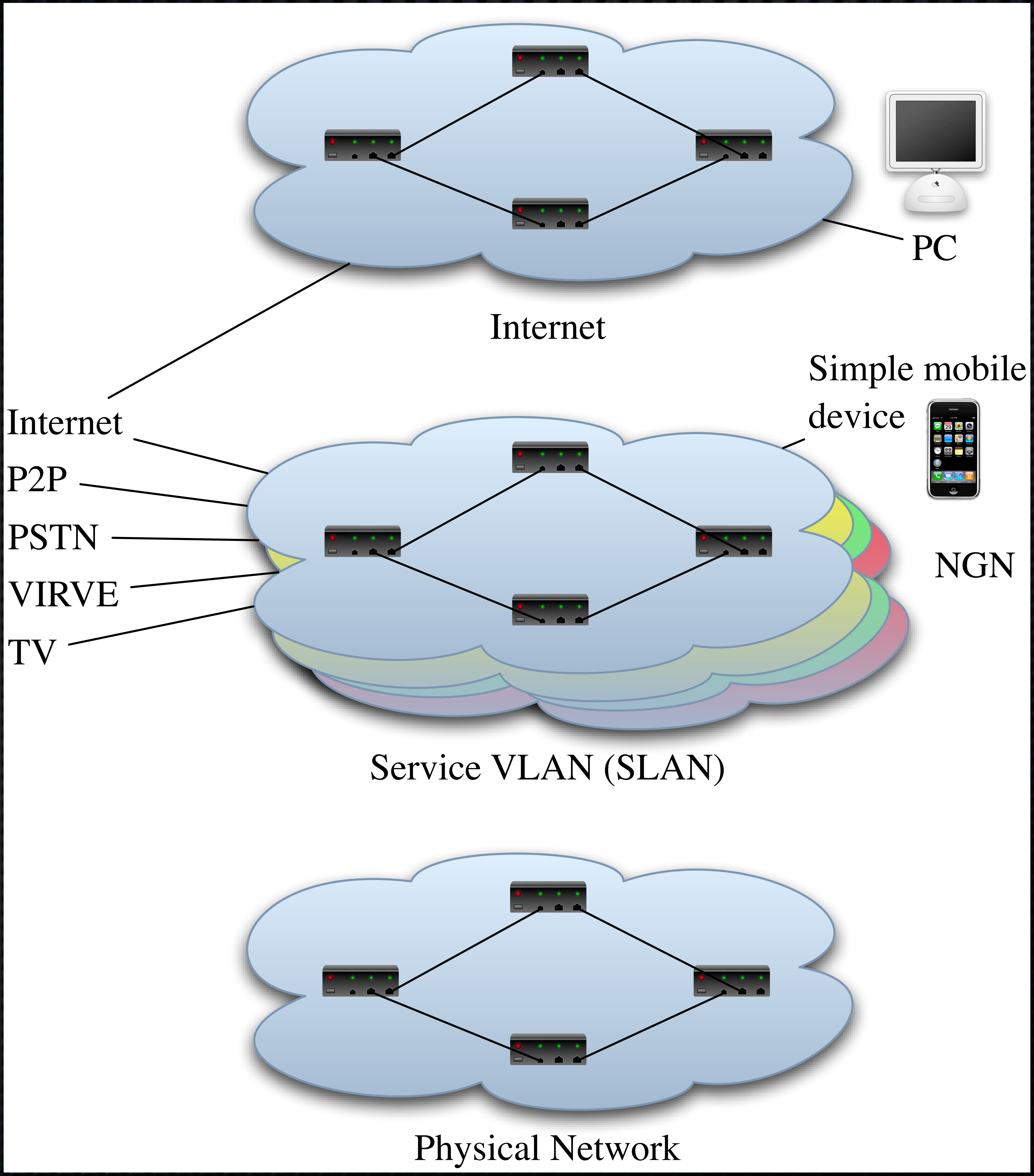
- The main idea is to use Ethernet instead of IP
- MAC addresses and NSAP addresses as network locators for hosts and servers
- Moving from layer 3 to layer 2 means that the technology must have routing capability
- Routing needs hierarchy in the addresses -> NSAP
- IS-IS could be the routing protocol for RE2EE

Network Structure in RE2EE

- Network Core
  - RE2EE network can have many network cores
- Service Core
  - Provides VPNs and Public Service Networks each in their own overlay
  - Supports parallel networks such as Internet, packet TV network, P2P network
- Mobility Layer
- User Identity Layer
  - Network Service Access Point (NSAP) addresses are used in the Provider side and MAC addresses are used in the user side

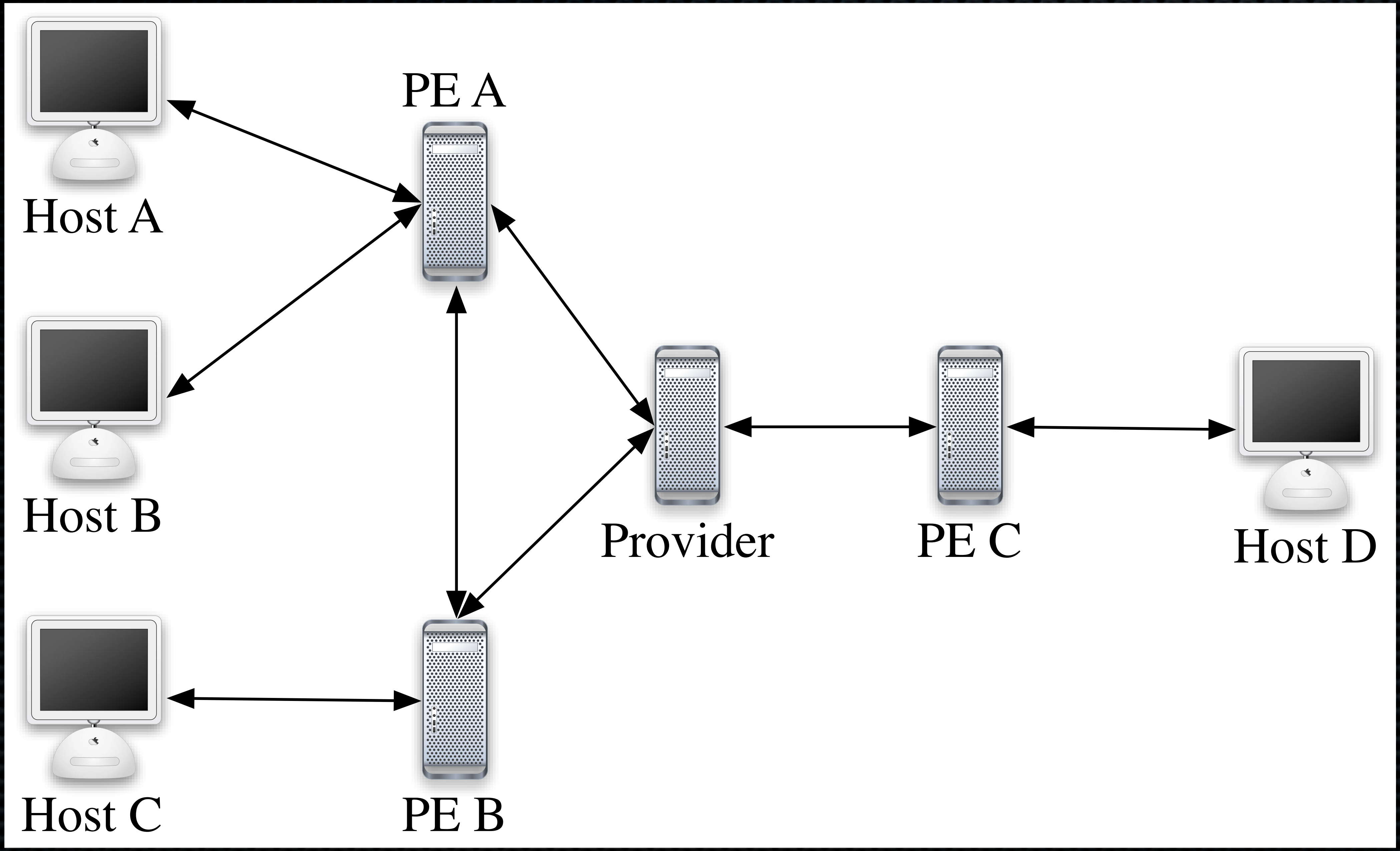
Service VLANs

- Internet
- P2P
- PSTN
- TV



Proof of Concept

- Proof of Concept does not implement all the features from the RE2EE concept
- Network is built on two PCs running Debian GNU/Linux
- Programming is done with Python
- Scapy is used for creating the Ethernet packets and sending/receiving them in the network
- Registry databases are created with MySQL

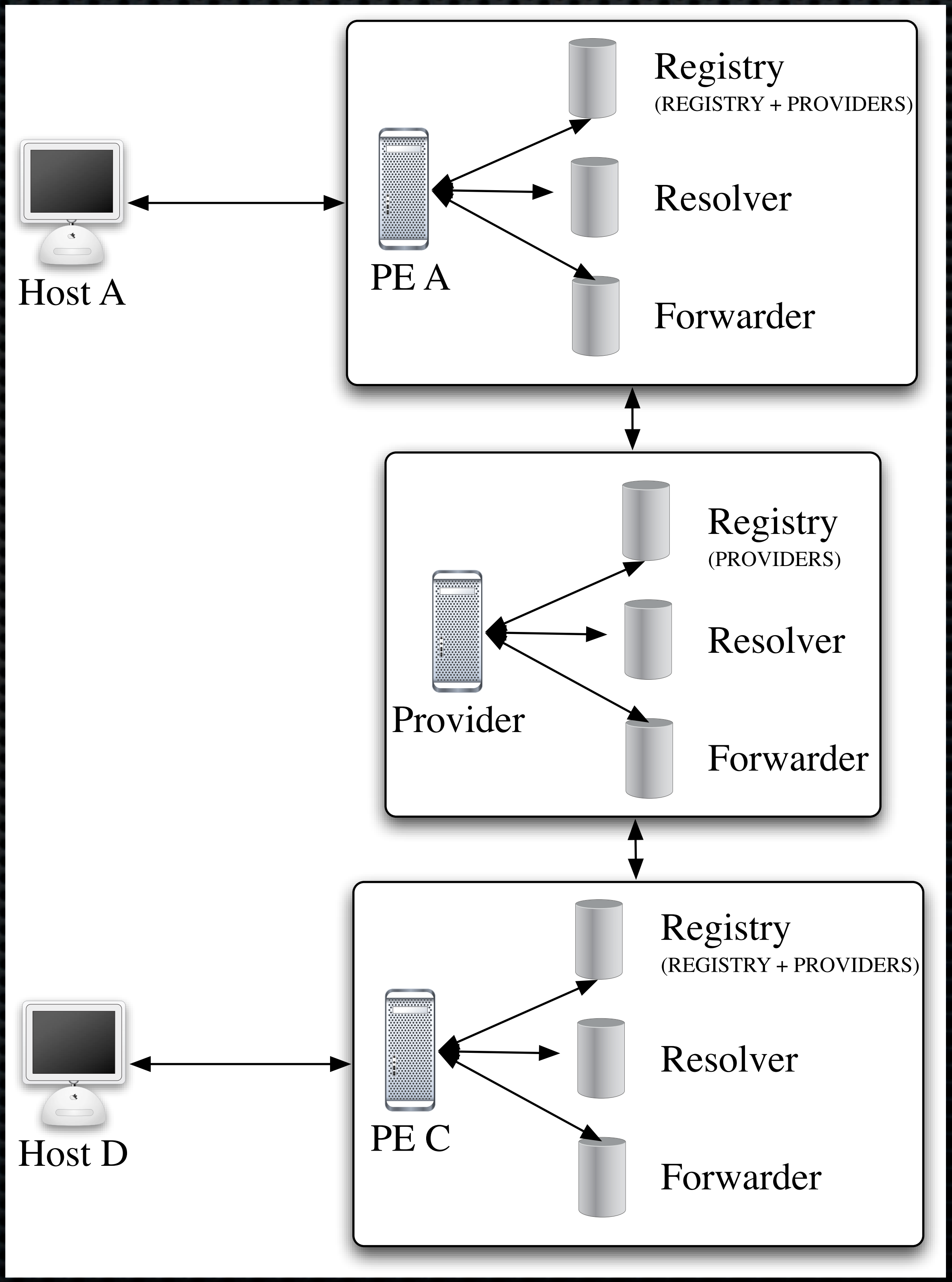


Network Diagram

4 hosts, 3 PE (Provider Edge) nodes and 1 Provider

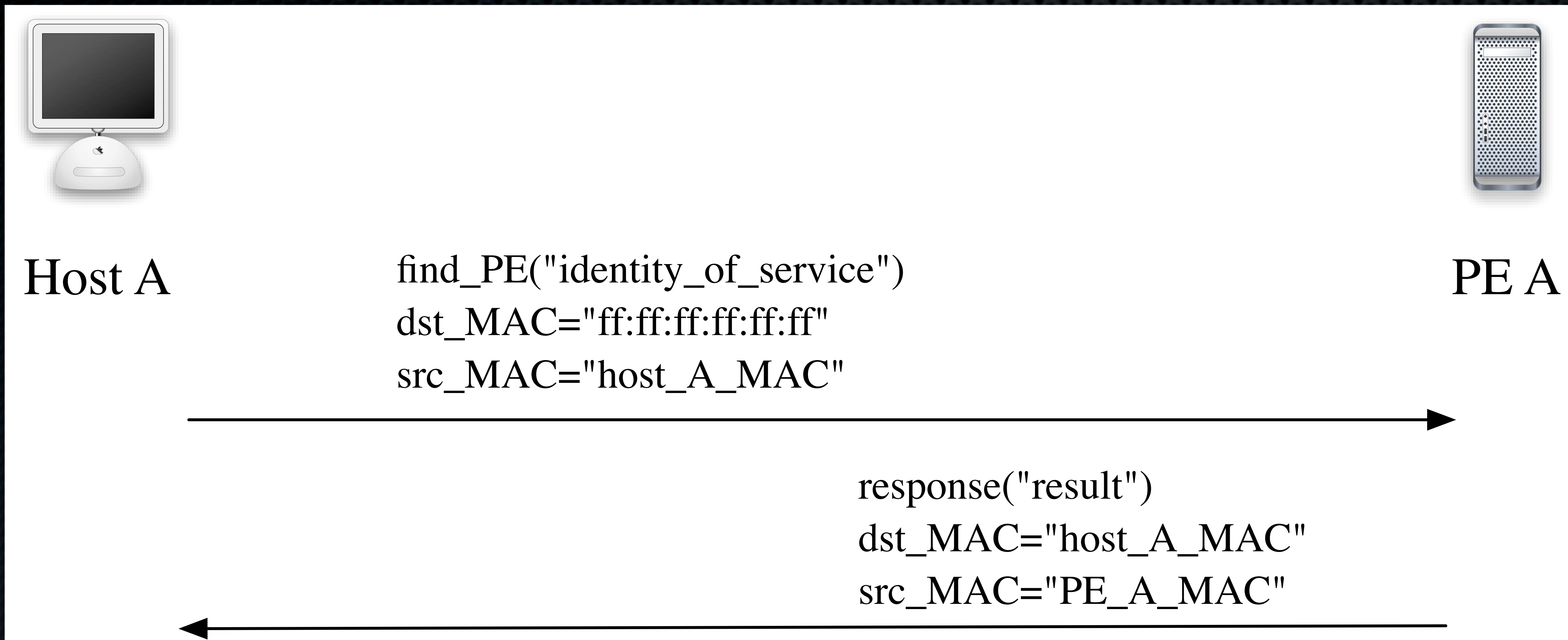
RE2EE Network Elements

- Host
- PE node
  - Registry database
    - REGISTRY and PROVIDERS tables
  - Resolver
  - Forwarder
- Provider
  - Registry database
    - PROVIDERS table
  - Resolver
  - Forwarder

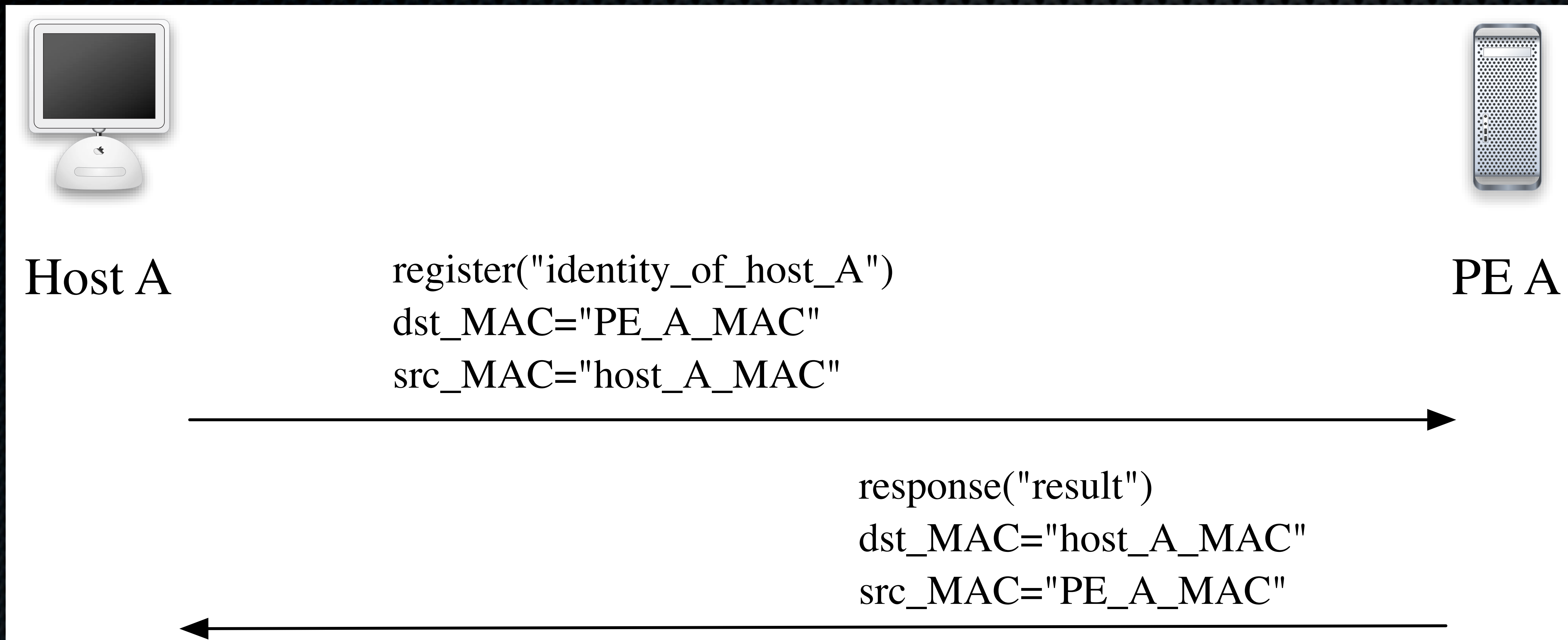


PoC Functionalities

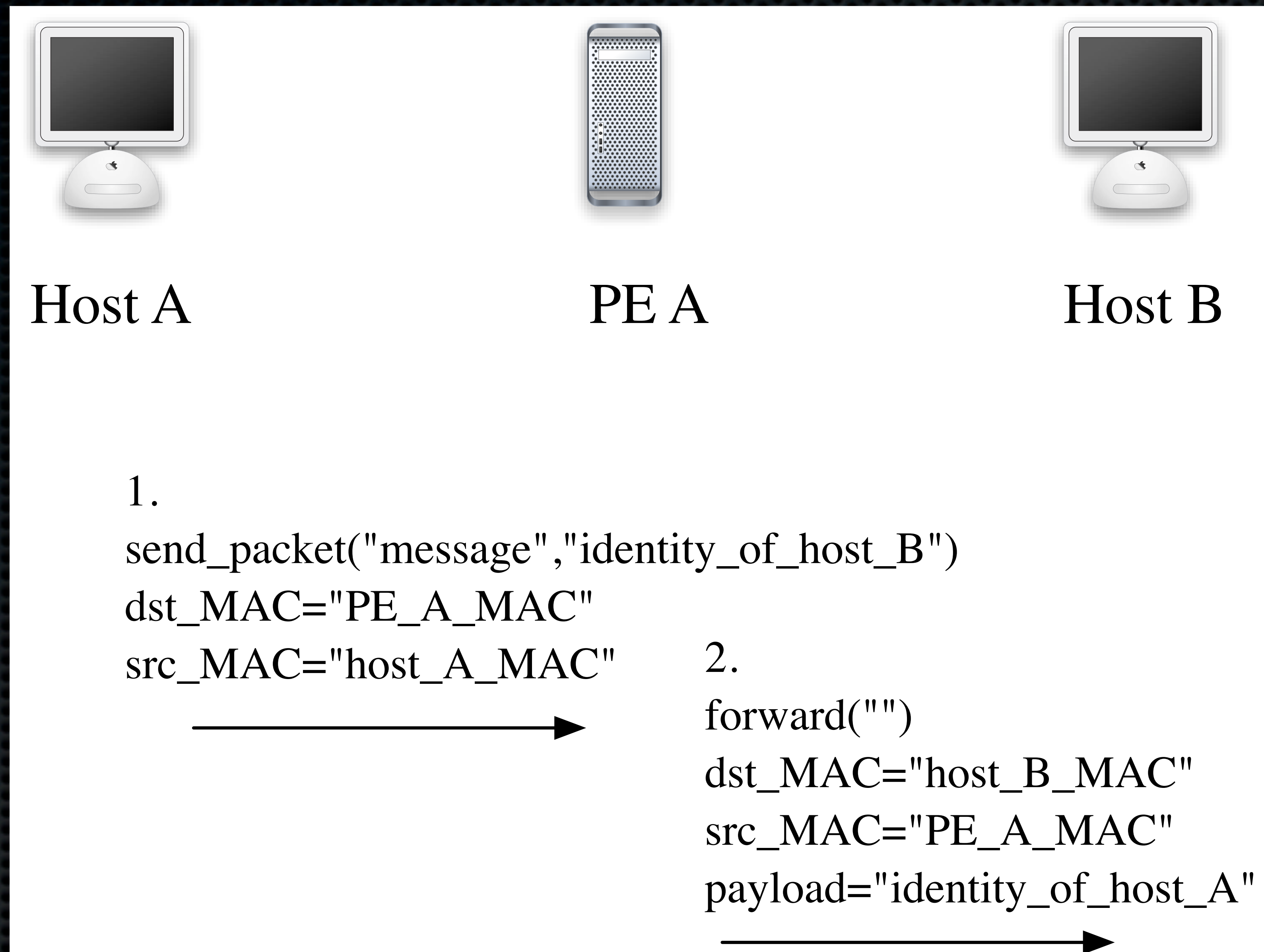
- Home PE discovery by a host
- Host registering to Home PE
- Host sending data to other host
- Host receiving data from other host
- Inactivation of a host



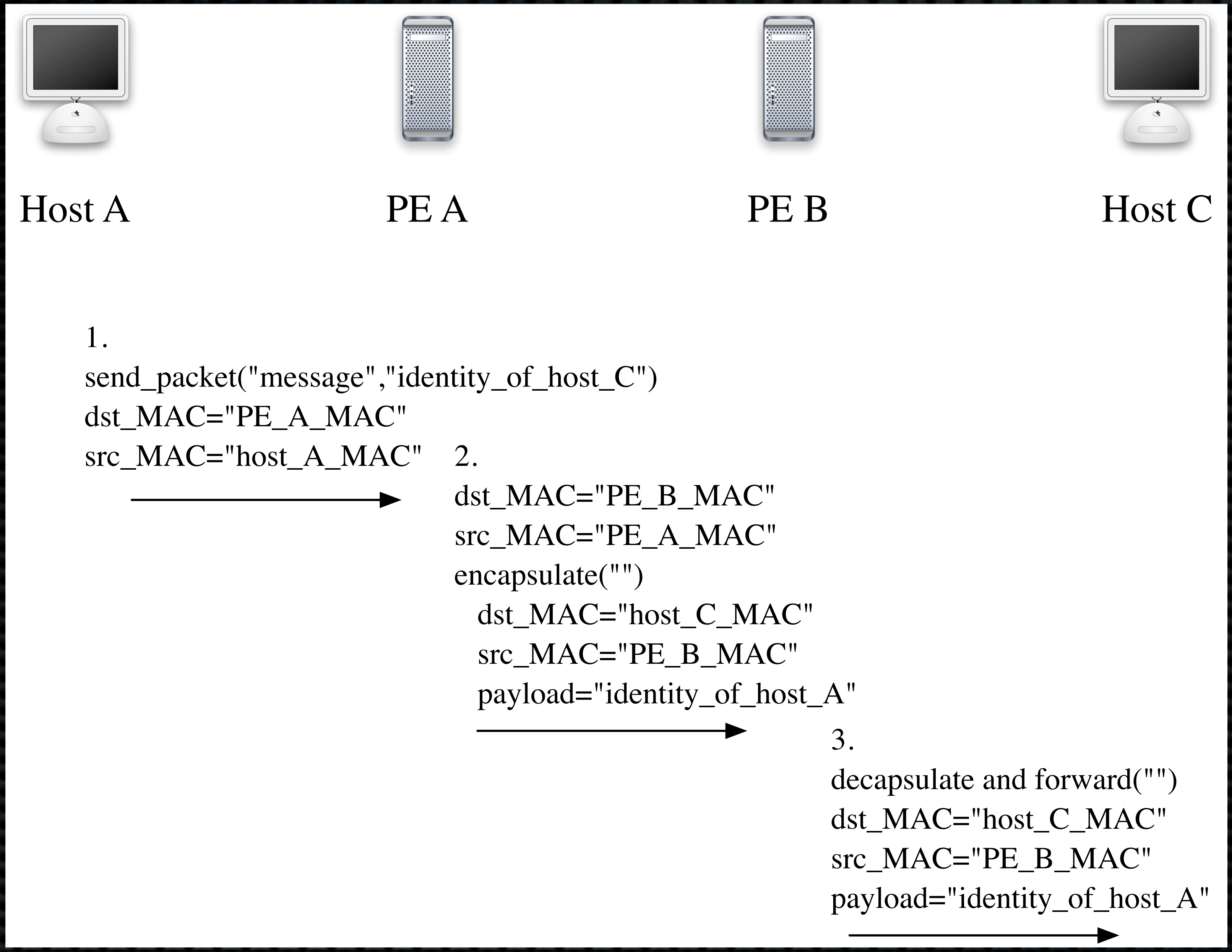
Home PE discovery by a host



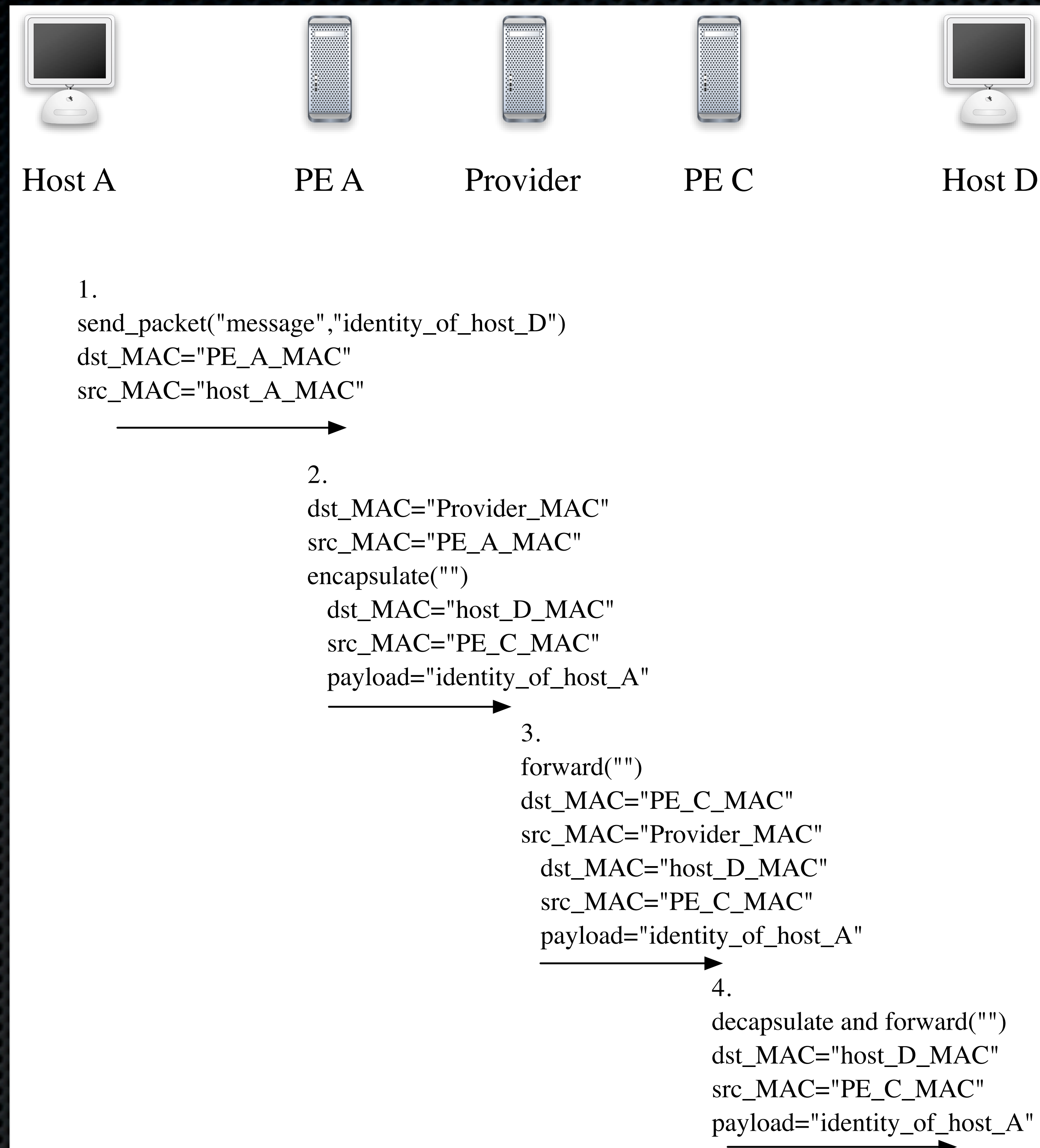
Host registering to Home PE



Host A sending a message to Host B under the same home PE node



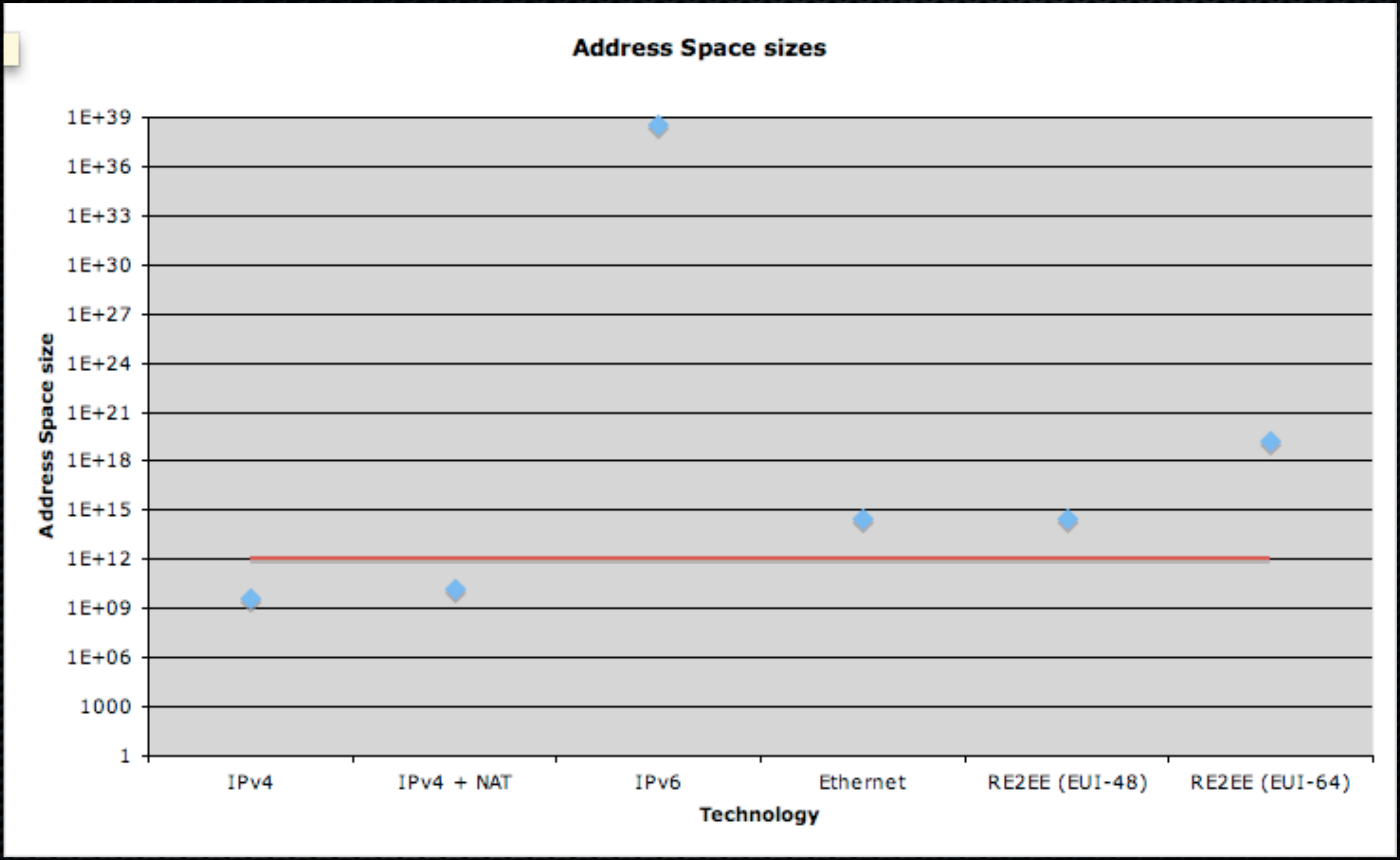
Host A sending a message to Host C via PE A and PE B



Host A sending a message to Host D via PE A, Provider and PE C

Results (1/2)

- There is a need for a new protocol in Internet for transmitting packets
- It needs to have the following features:
  - Large address space
  - Routing
  - Scalability
  - Security



Address Space sizes

Results (2/2)

- Routing
  - Addresses need to have global hierarchy
  - Ethernet has only Spanning Tree Protocol for routing -> need for better routing protocol like IS-IS
- Scalability
  - One Routed Ethernet Provider Edge device can serve a minimum of 50 000 users
  - There are about 1 billion Internet users all around the world
  - Less than 20 000 devices are needed to serve 1 billion users

Results from the PoC

- PoC showed that it is possible to build a RE2EE network with small modifications
- No IP addresses were used
- Ethernet with registry database is enough for forwarding the traffic
- Using only identities for communicating hides the network from the hosts

Conclusions

- Routed End-to-End Ethernet would provide a long lasting solution to the problems, which we are having at the moment in the Internet
- RE2EE solution provides large enough address space, hierarchy, routing, security and scalability
- It is possible to use the same hosts in RE2EE network as in IP network

Future Research

- Make RE2EE network to work with IP networks
- Exact form of NSAP address
- Implement IS-IS routing
- Service discovery for different services
- Mobility management

Questions?