PATTERNS IN NETWORK ARCHITECTURE:

HORIZONTAL COMPOSITION OR BRIDGING,

AND

AN INTRODUCTION TO SECURITY

OUTLINE

UNFINISHED BUSINESS

- **Understanding VLANs**

- **Alloy exercises**

HORIZONTAL COMPOSITION OR BRIDGING
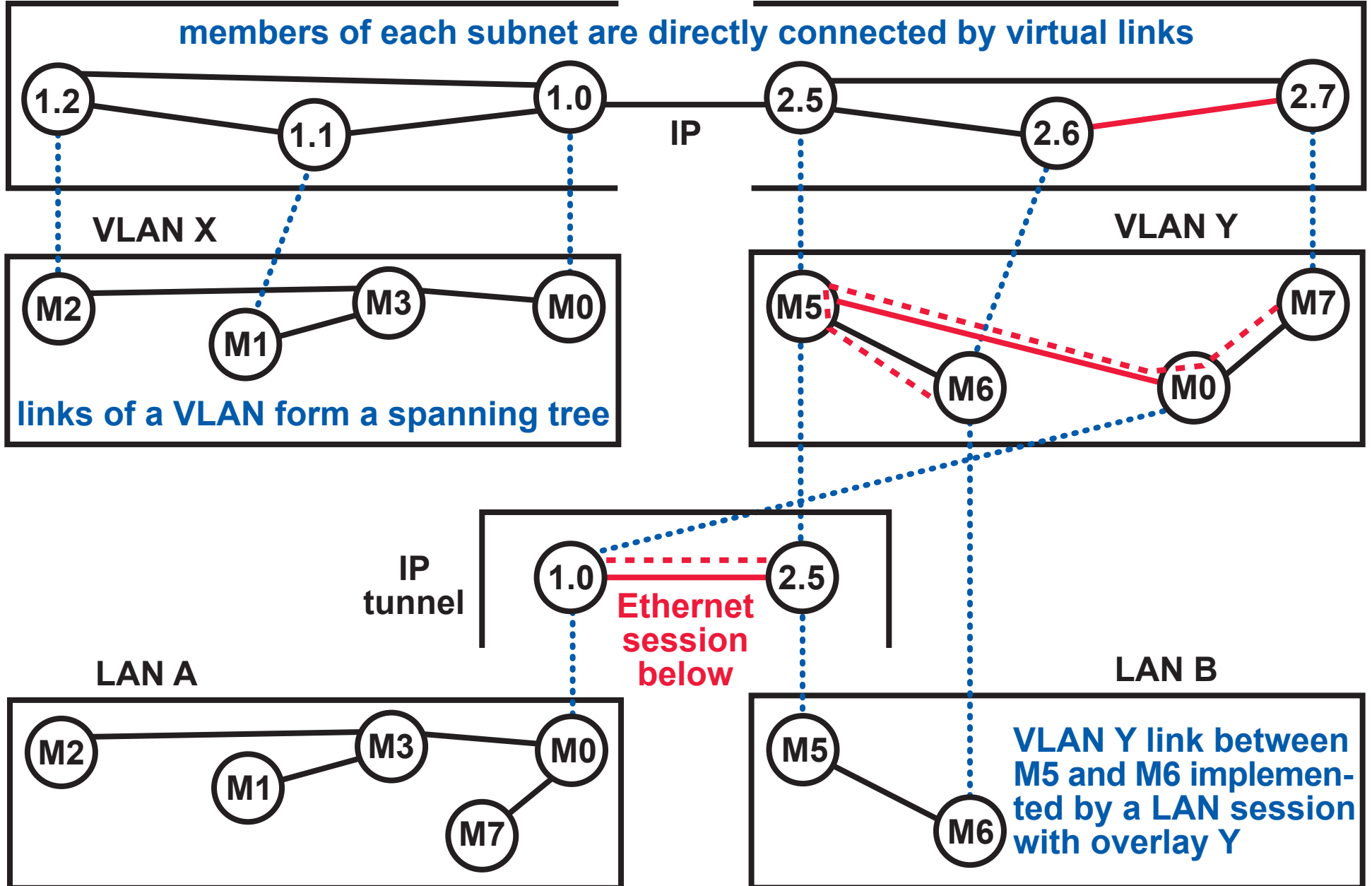
INTRODUCTION TO SECURITY

- **Discussion of "Rethinking the design of the Internet: The end-to-end arguments vs. the brave new world**

- **Discussion of "Accountable Internet Protocol (AIP)"**

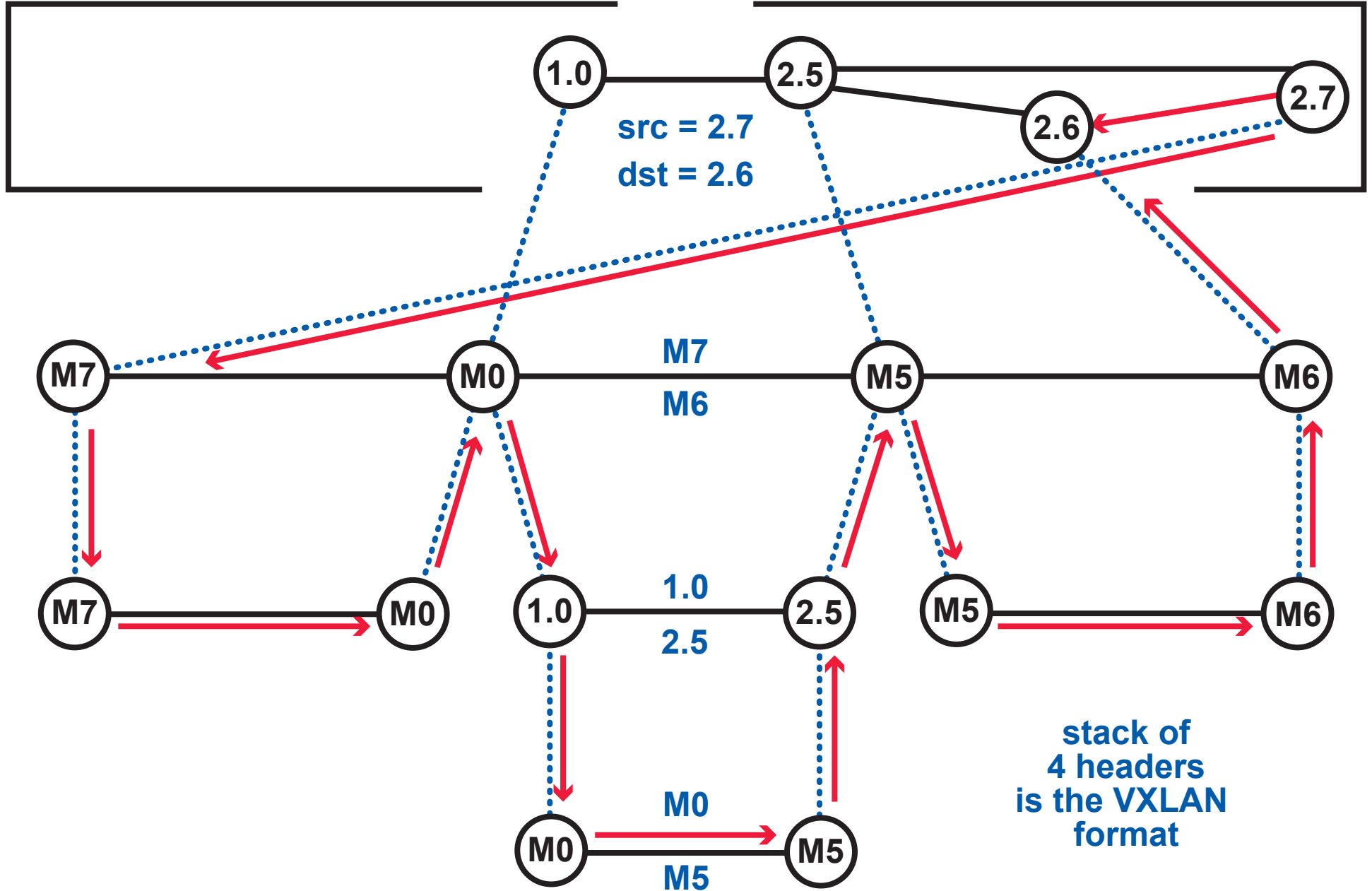**A ROAD MAP**

VLAN TECHNOLOGY

IP SUBNETWORK, PREFIX 192.168.1/24   **IP SUBNETWORK, PREFIX 192.168.2/24**

members of each subnet are directly connected by virtual links

1.2   1.1   1.0   IP   2.5   2.6   2.7

VLAN X   VLAN Y

M2   M3   M0   M1

links of a VLAN form a spanning tree

M5   M6   M0   M7

IP tunnel   1.0   2.5

Ethernet session below

LAN A   LAN B

M2   M3   M0   M1   M7

M5   M6

VLAN Y link between M5 and M6 implemented by a LAN session with overlay Y

VXLAN TECHNOLOGY

IP SUBNETWORK, PREFIX 192.168.1/24　　　**IP SUBNETWORK, PREFIX 192.168.2/24**

src = 2.7
dst = 2.6

M7
M6

1.0
2.5

M0
M5

stack of
4 headers
is the VXLAN
format

UNDERSTANDING THE COMPOSITION

IP SUBNETWORK, PREFIX 192.168.1/24 **IP SUBNETWORK, PREFIX 192.168.2/24**

1.0 — 2.5 — 2.6 — 2.7

src = 2.7
dst = 2.6

M7 — M0 — M5 — M6

M7
M6

VLAN Y

LAN A
M7 — M0

IP 1.0
1.0 — 2.5
2.5

LAN B
M5 — M6

LAN M0
M0 — M5
M5
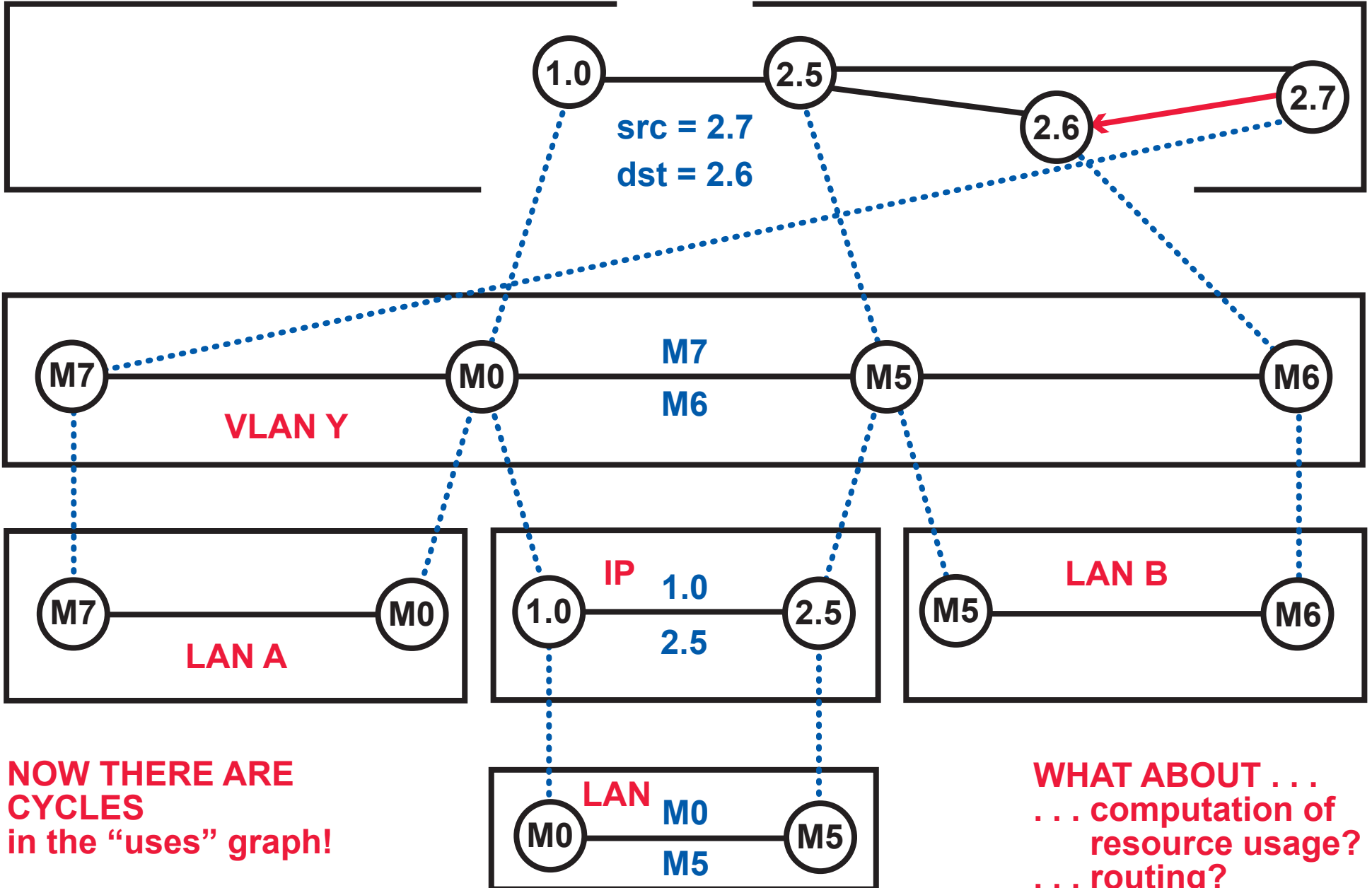
NOW THERE ARE CYCLES
in the "uses" graph!

WHAT ABOUT . . .
. . . computation of
        resource usage?
. . . routing?

COMPUTATION OF RESOURCE USAGE

MUST COMPUTE ALL USES OF A LINK

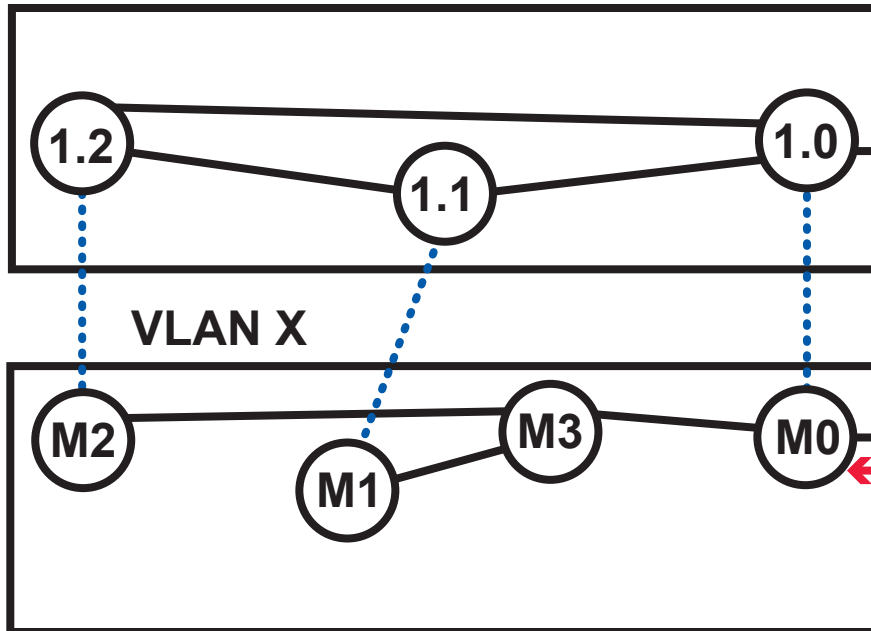IP SUBNETWORK, PREFIX 192.168.1/24   IP SUBNETWORK, PREFIX 192.168.2/24
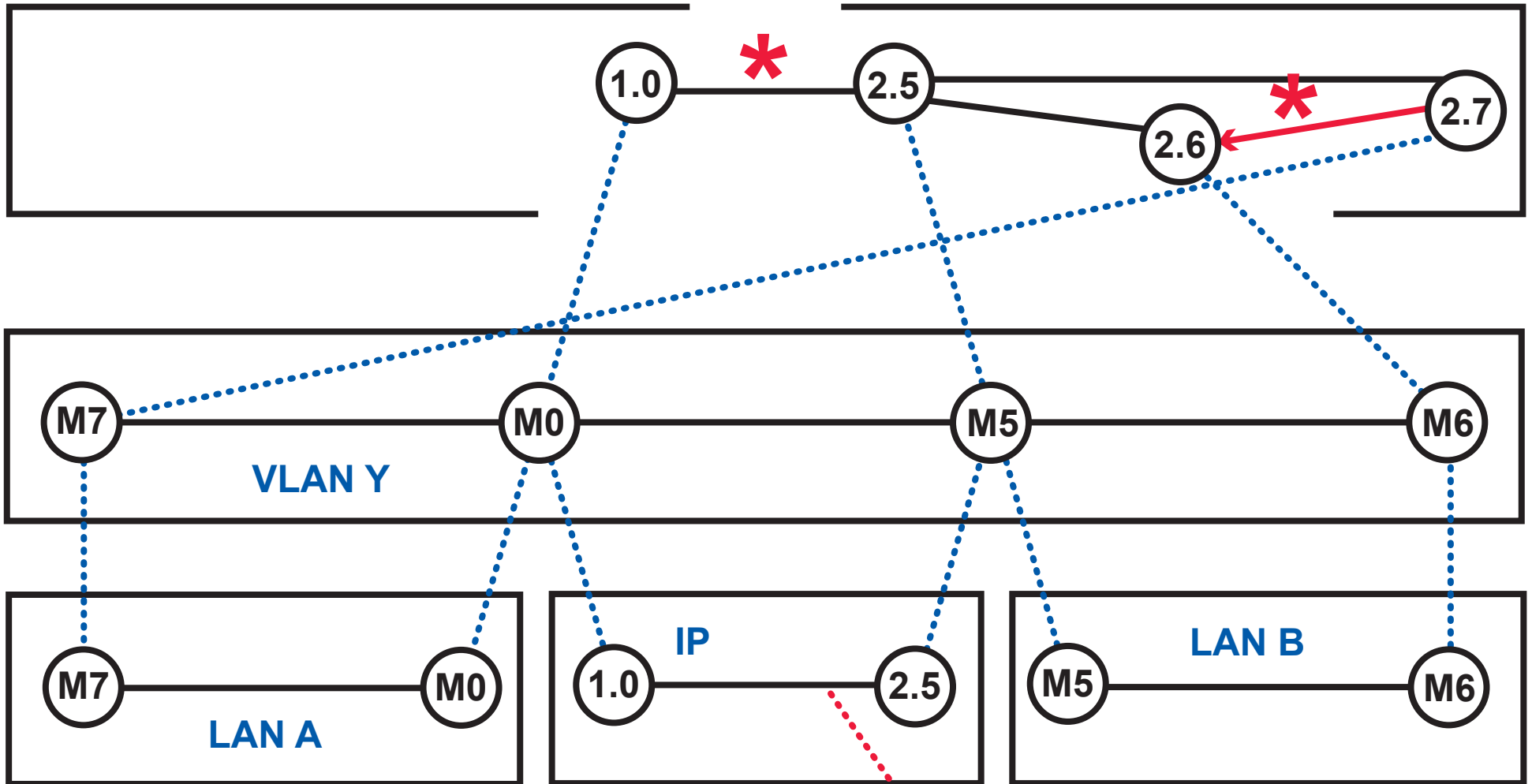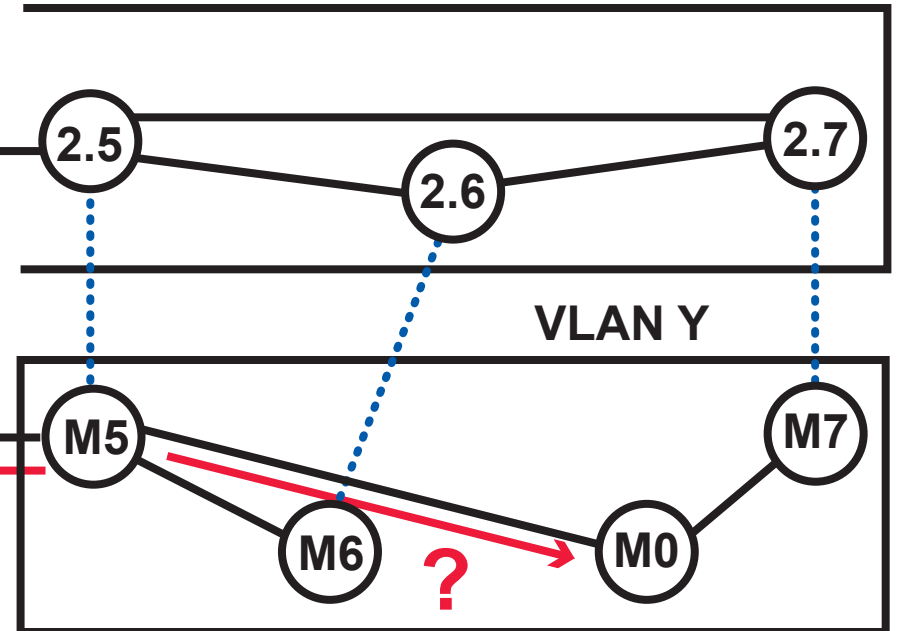

✳ links use this link

ROUTING

**WITH THE VXLAN ARCHITECTURE,
ROUTING IN EVERY NETWORK IS NORMAL**

IP SUBNETWORK, PREFIX 192.168.1/24
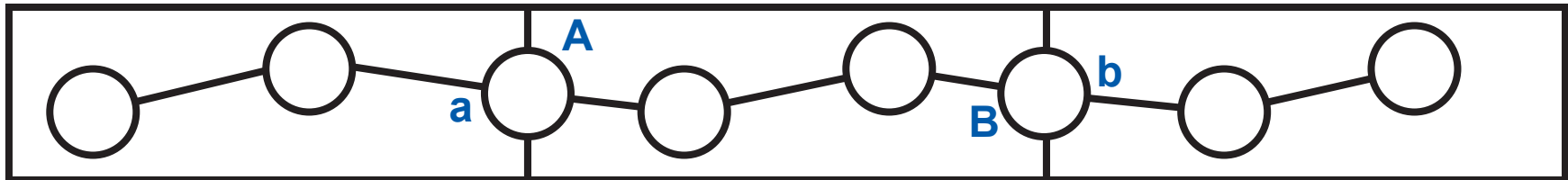
IP SUBNETWORK, PREFIX 192.168.2/24

1.2 1.1 1.0 IP 2.5 2.6 2.7

VLAN X

VLAN Y

M2 M1 M3 M0 ? M5 M6 ? M0 M7

**WITHOUT IT,
M5 CANNOT ROUTE TO M0**

BRIDGING OR HORIZONTAL COMPOSITION 1

TWO NETWORKS ARE BRIDGED IF THEY HAVE ONE OR MORE COMMON MEMBERS

A MEMBER OF MULTIPLE NETWORKS HAS A NAME IN EACH, WHICH NEED NOT BE THE SAME

a member of two networks can forward packets from one to the other, i.e., its forwarding table mixes links of both networks

so their routing mechanisms must be shared or must interact
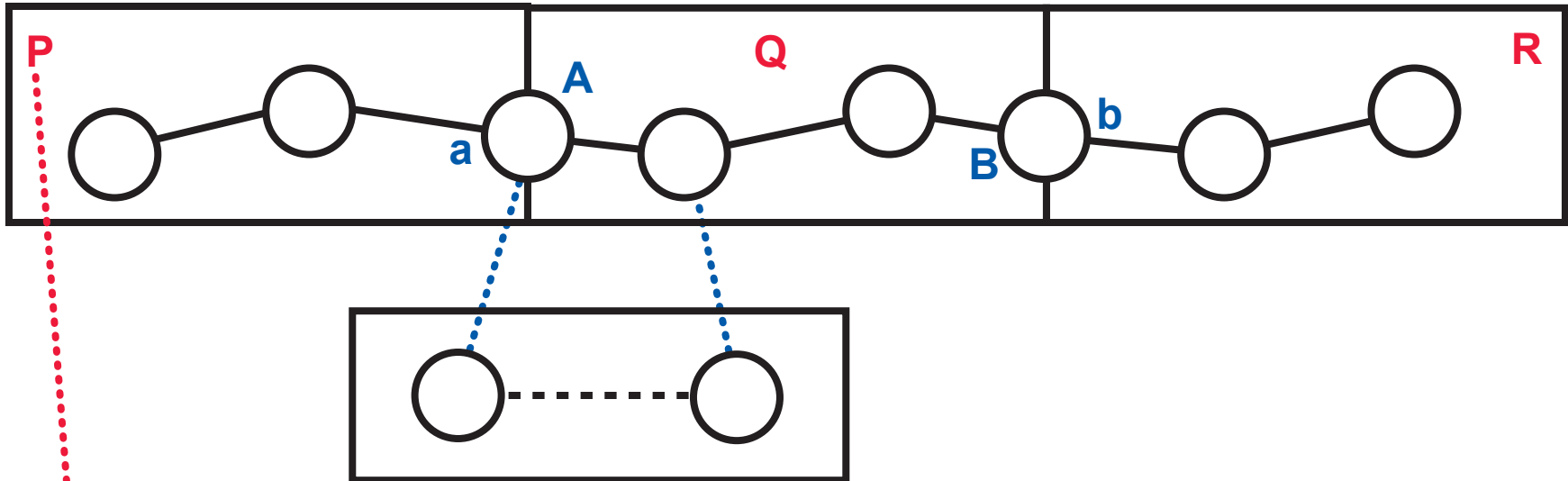
WHAT BRIDGED NETWORKS MUST SHARE

WHAT BRIDGED NETWORKS DO NOT SHARE

- **name space**
- **session protocols**
- **sessions**

- **naming**
- **links**

BRIDGING OR HORIZONTAL COMPOSITION 2

WHAT IS THE INTERACTION BETWEEN BRIDGING AND LAYERING BELOW IT?

there is no interaction between bridging and anything it is layered over, because the links of the bridged networks are not shared
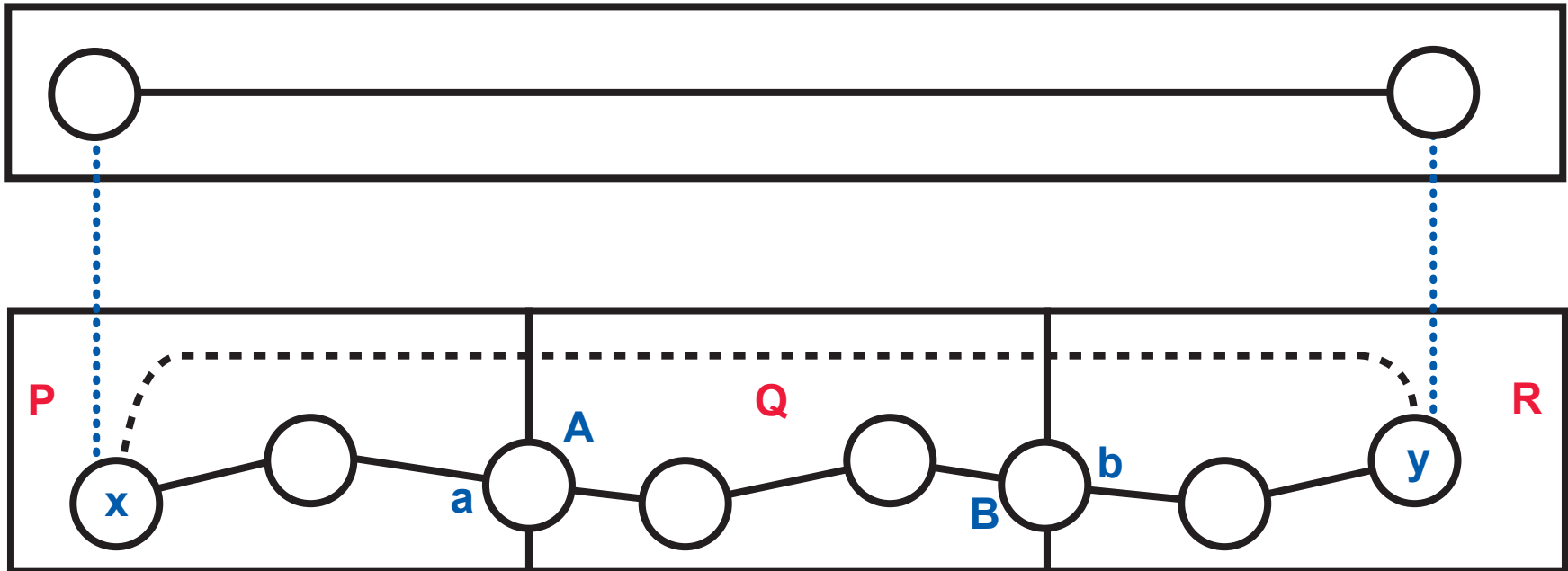
note that each bridged network retains a distinct name

BRIDGING OR HORIZONTAL COMPOSITION 3

WHAT IS THE INTERACTION BETWEEN BRIDGING AND LAYERING ABOVE IT?

Case 1: Names are unique across an entire set of bridged networks.

In this case any link in an overlay can be implemented by a session in the set of bridged networks.
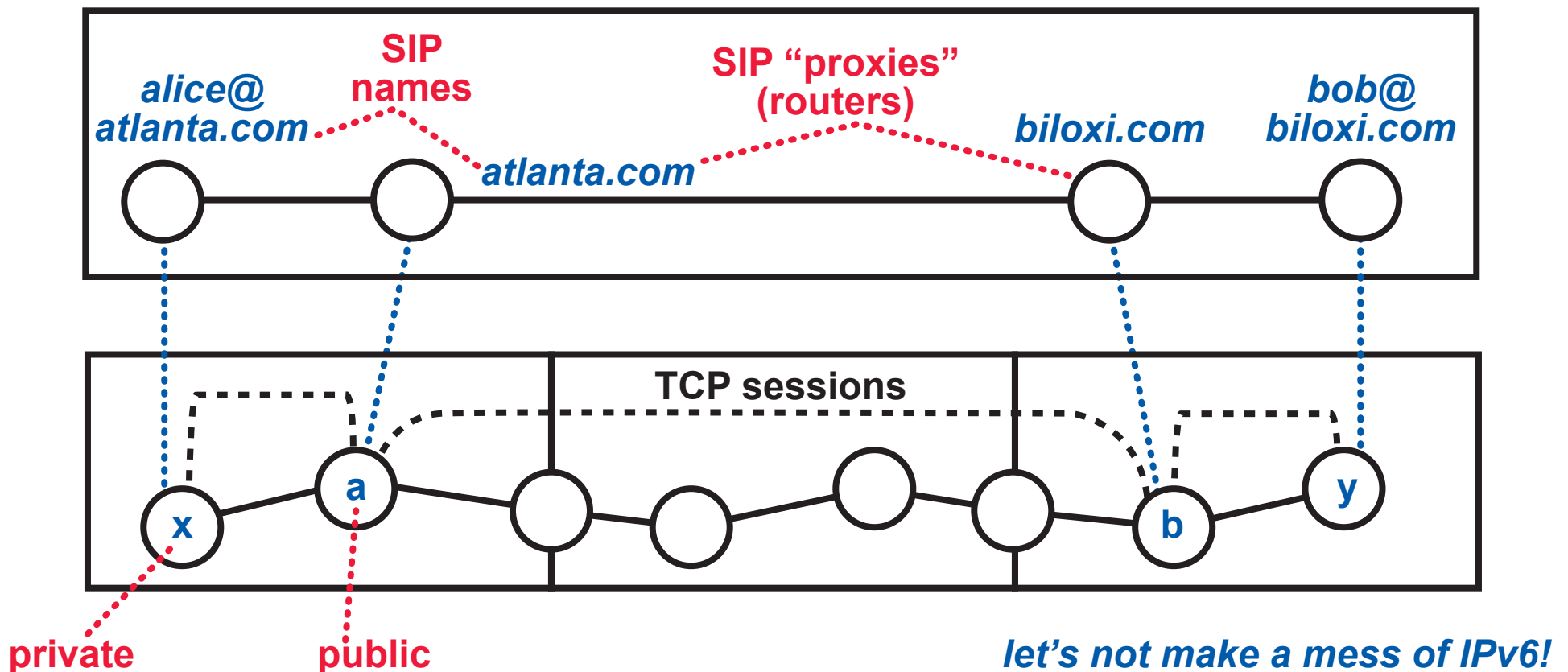
BRIDGING OR HORIZONTAL COMPOSITION 4

Case 1: Names are not unique across an entire set of bridged networks.

*unfortunately this is the case for IPv4, and it is a mess*

one so-called "solution"
is a Network Address Translator (NAT)

here is a better solution, used for example by SIP signaling (voice-over-IP)

alice@
atlanta.com

SIP names

SIP "proxies" (routers)

biloxi.com

bob@
biloxi.com

atlanta.com

TCP sessions

a

x

b

y

private

public

let's not make a mess of IPv6!

BRIDGING OR HORIZONTAL COMPOSITION 5

THE MOST INTERESTING THING ABOUT BRIDGING IS THAT THE BRIDGING BOUNDARIES ARE, TRADITIONALLY, THE BOUNDARIES OF TRUST!
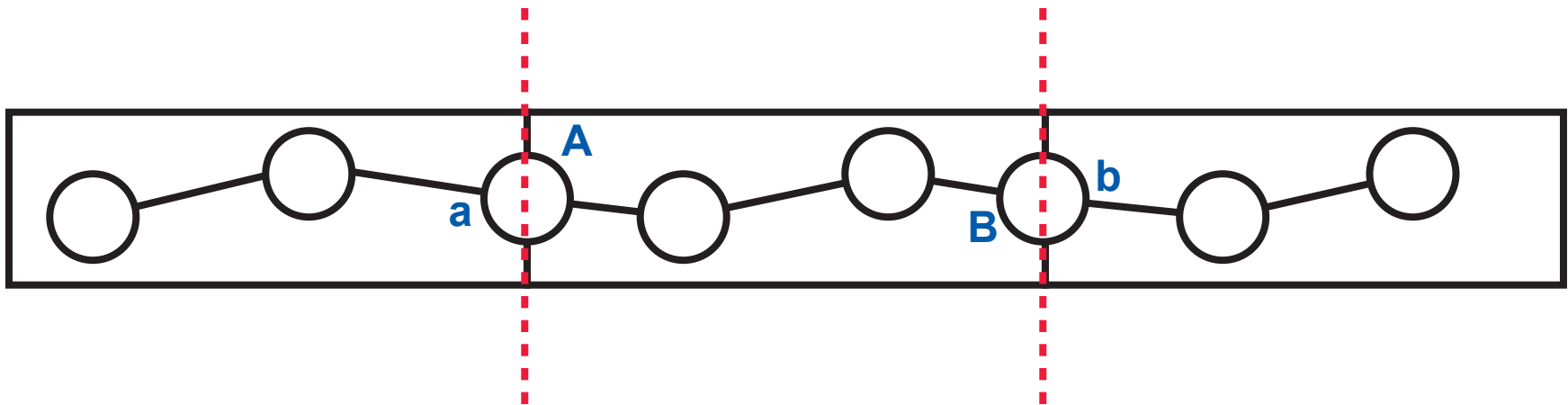
*trust is fundamental to security—
who or what is a friend,
and who or what is a potential enemy?*