PATTERNS IN NETWORK ARCHITECTURE:

PRINCIPLES FOR BRIDGING

REACHABILITY

The only purpose for bridging is to extend the reach of networks.

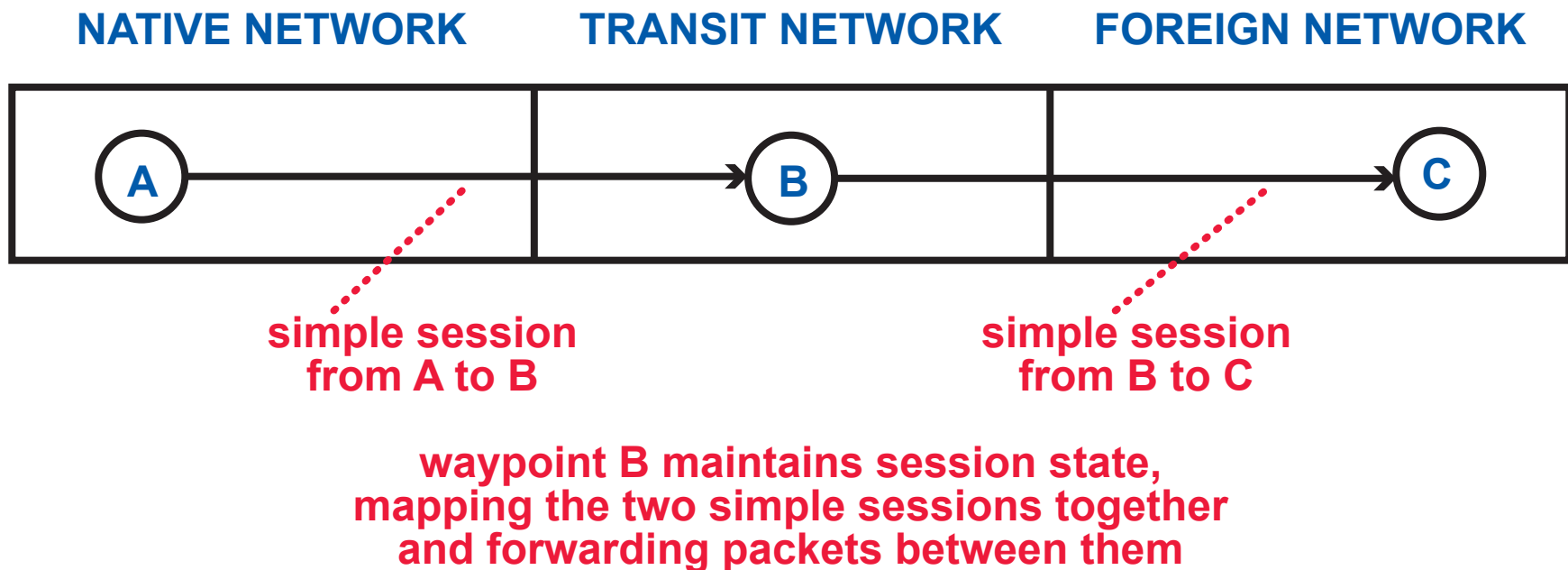| NATIVE NETWORK	TRANSIT NETWORK	FOREIGN NETWORK

**From a member of a native network,
a member of a foreign network is reachable if:**

- its name is in the name space of the native network and all necessary transit networks

- its name does not have a different meaning in the native network or any necessary transit network

- there is (or can be, in the case of "pull" routing) a forwarding path to the foreign member

- the native member and the foreign member have a session protocol in common

WHAT IF . . . ?

- its name is NOT in the name space of the native network and all necessary transit networks

- its name HAS a different meaning in the native network or a necessary transit network

- there is NO forwarding path to the foreign member

THEN THE ONLY SOLUTION IS A COMPOUND SESSION

NATIVE NETWORK   **TRANSIT NETWORK**   **FOREIGN NETWORK**

A → B → C

simple session
from A to B

simple session
from B to C

waypoint B maintains session state,
mapping the two simple sessions together
and forwarding packets between them

CREATION OF A (COMPOUND) SESSION

SIMPLE SESSION INITIATOR

1 **if node is the source of the whole session, may get namelist from directory lookup**

namelist has at least one entry, and the first entry is reachable from here

2 **send packet to initiate simple session from here to destination head [namelist], carrying tail [namelist] as namelist**

carried namelist can be empty

SIMPLE SESSION ACCEPTOR

3 **receive packet initiating simple session from source to here, carrying namelist**

carried namelist can be empty

4 **optionally append entries to namelist**

if namelist is still empty, . . .

5 **then node is the destination of the whole session, . . .**
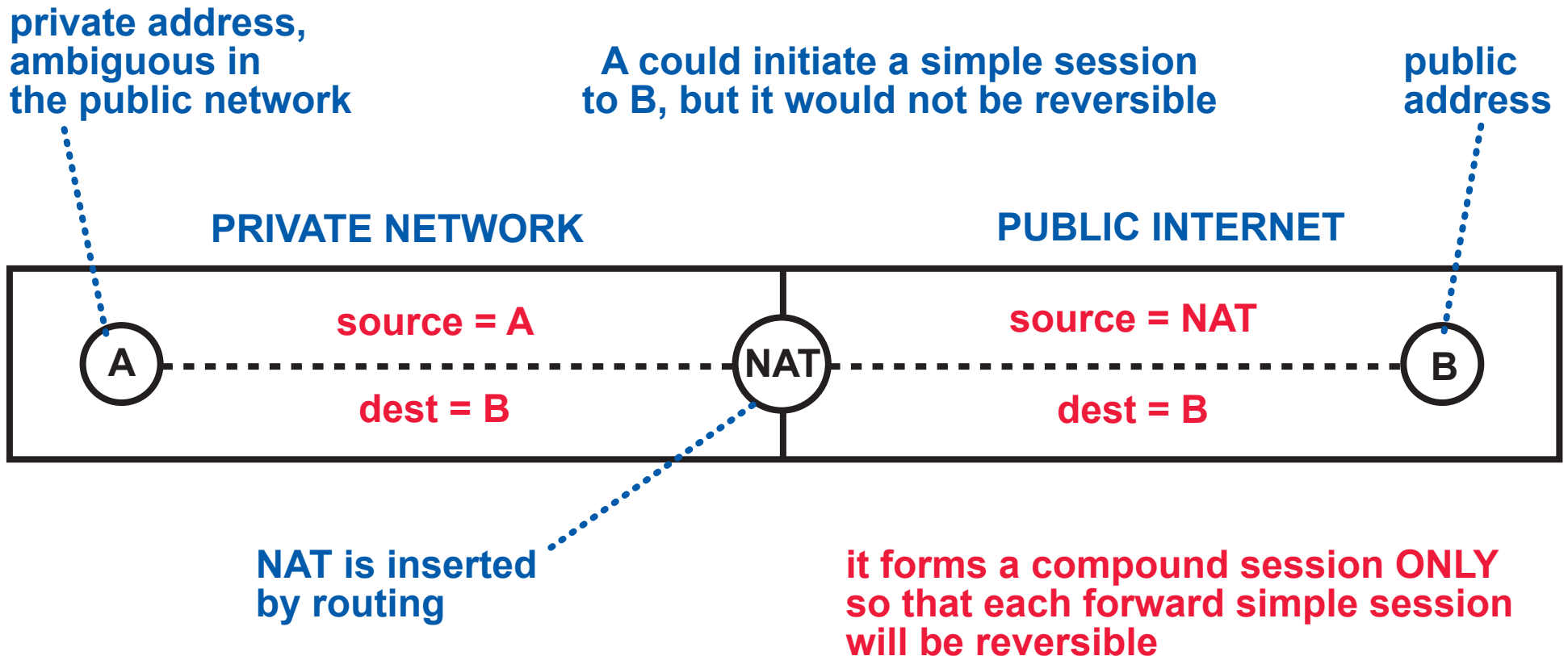
else (first entry must be reachable from here) go to 2

TWO-WAY COMPOUND SESSIONS

**WHAT IF THE SESSION PROTOCOL IS TWO-WAY,
REQUIRING A REVERSE SESSION?**

**If reachability is reversible in each simple session,
then the reverse session can simply reverse each simple session
(it will be compound if the forward session is).**

If reachability is not reversible in each simple session (the NAT case):

private address,
ambiguous in
the public network

A could initiate a simple session
to B, but it would not be reversible

public
address

PRIVATE NETWORK

PUBLIC INTERNET

source = A

source = NAT

A ---- NAT ---- B

dest = B

dest = B

NAT is inserted
by routing

it forms a compound session ONLY
so that each forward simple session
will be reversible

THE REMAINING REACHABILITY PROBLEM

**From a member of a native network,
a member of a foreign network is reachable if:**

- the native member and the foreign member have a session protocol in common

This problem can be solved with a middlebox that does protocol conversion.

- remember that signaling in a session can be piecewise or end-to-end

Compound sessions can also be used to introduce middleboxes, even when there are no reachability problems.

- in this case, modification of the namelist (Step 4) can insert as well as append entries

A quote from

"Looking over the Fence at Networks: A Neighbors' View of Networking,"

National Research Council, 2001:

"The traditional Internet model pushes the intelligence to the edge,
and calls for a simple data forwarding function in the core of the network.
Does this continue to be the correct model?
A number of ad hoc functions are appearing in the network, such as NAT boxes,
firewalls, and content caches. There are devices that transform packets,
and places where the network seems to operate as an overlay on itself
(e.g., virtual private networks).
Do these trends signal the need to rethink
how function is located within the network?
What aspects of modularity need to be emphasized in the design of functions:
protocol layering, topological regions, or administrative regions?
Is there a need for a more complex model
for how applications should be assembled
from components located in different parts of the network?"

NOW YOU KNOW THE ANSWERS!