Systèmes Distribués

Master MIAGE 1

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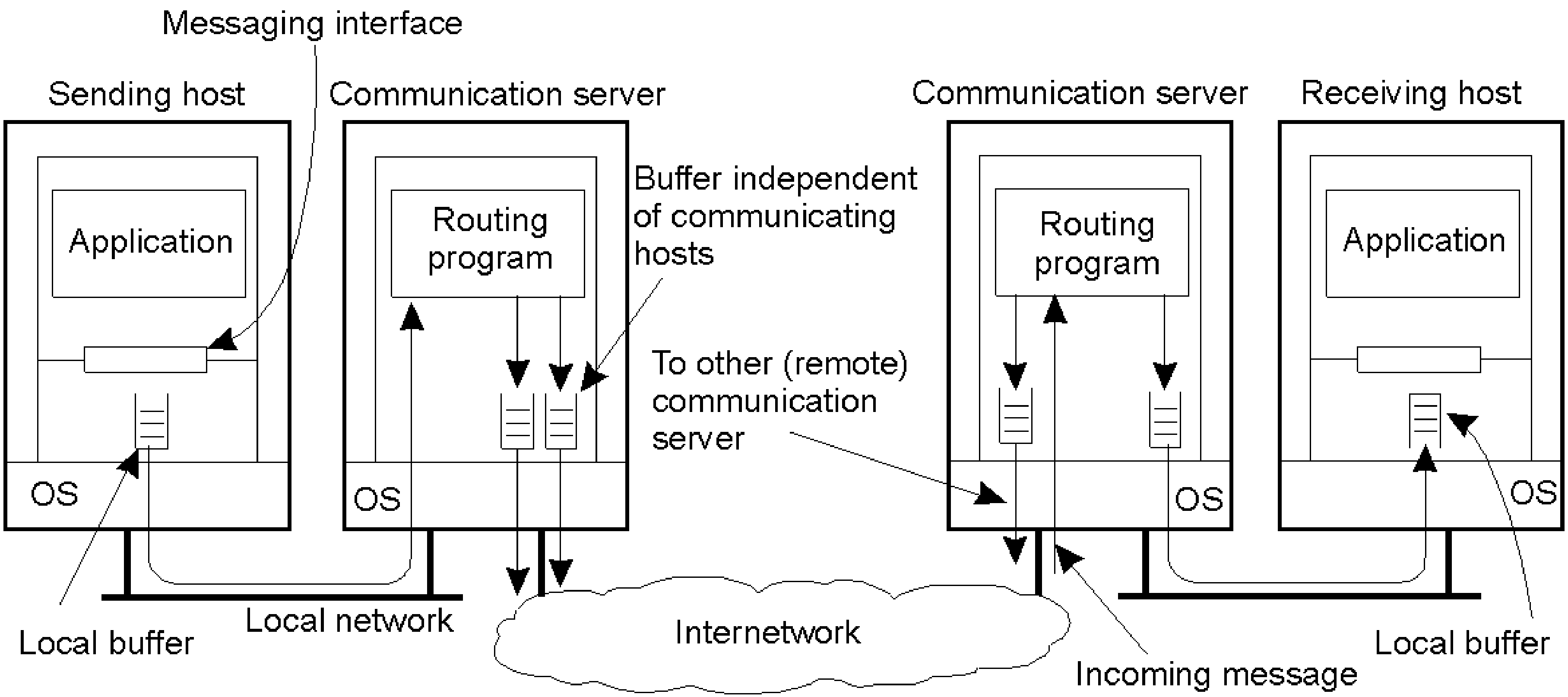
CM - Séance 3 – Partie II

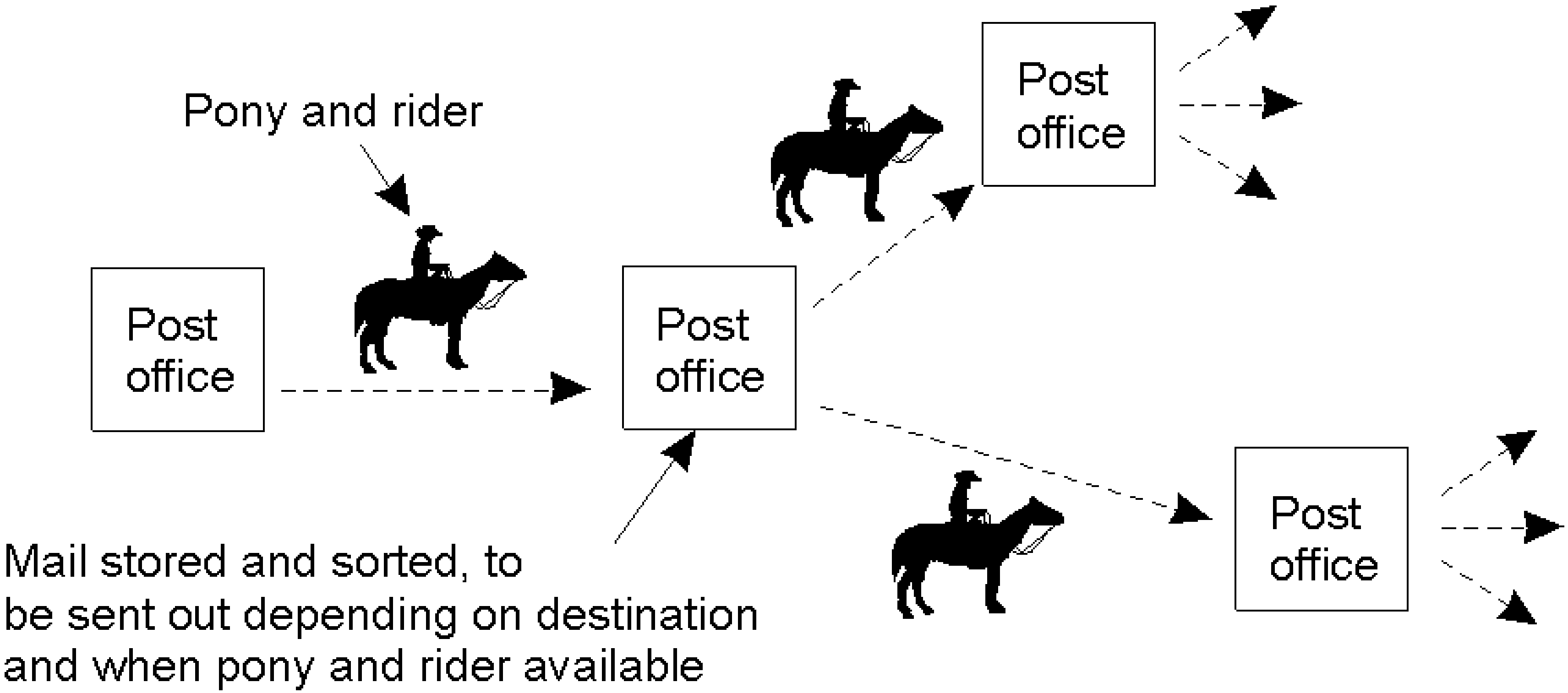
Communication orienté message et flot, Multicasting

Persistence and Synchronicity (1)



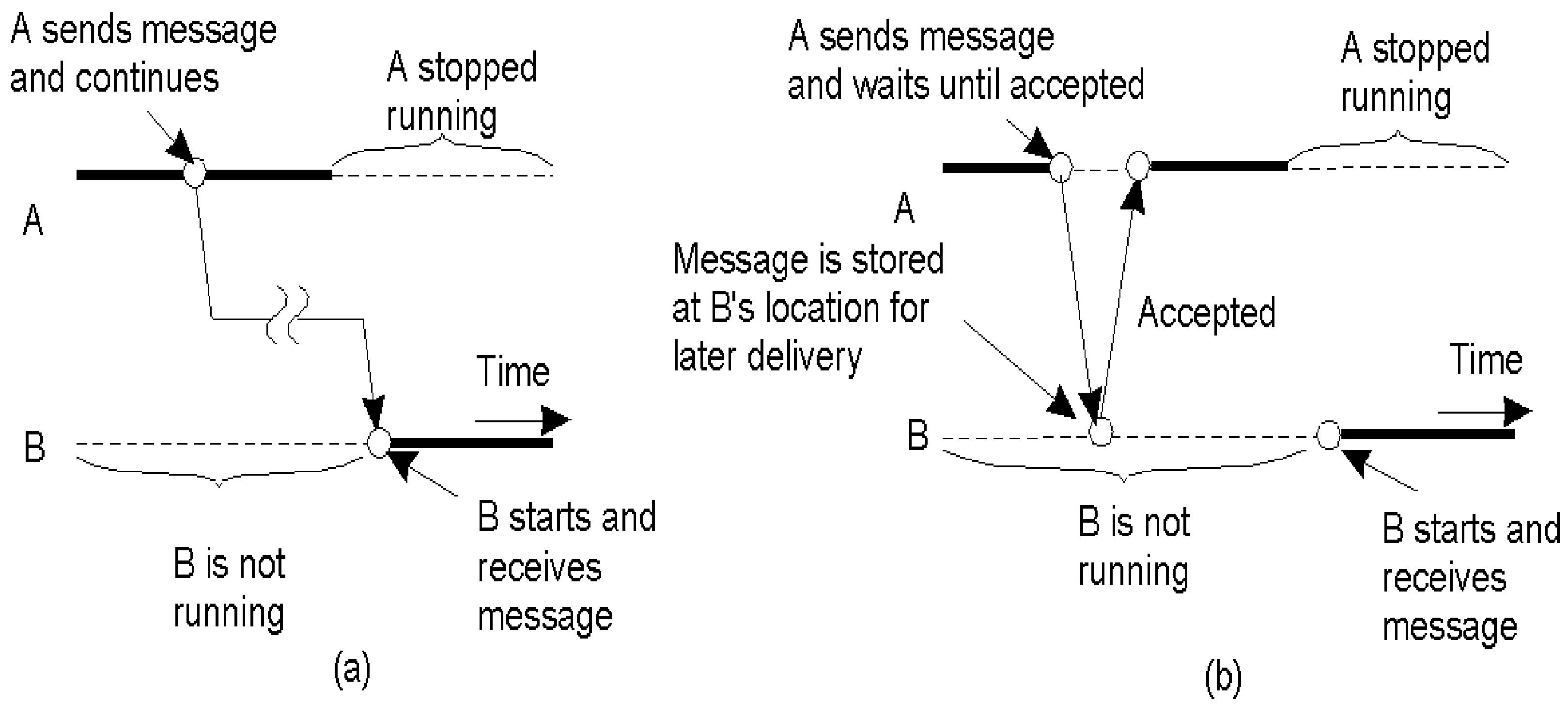
General organization of a communication system in which hosts are connected through a network

Persistence and Synchronicity (2)



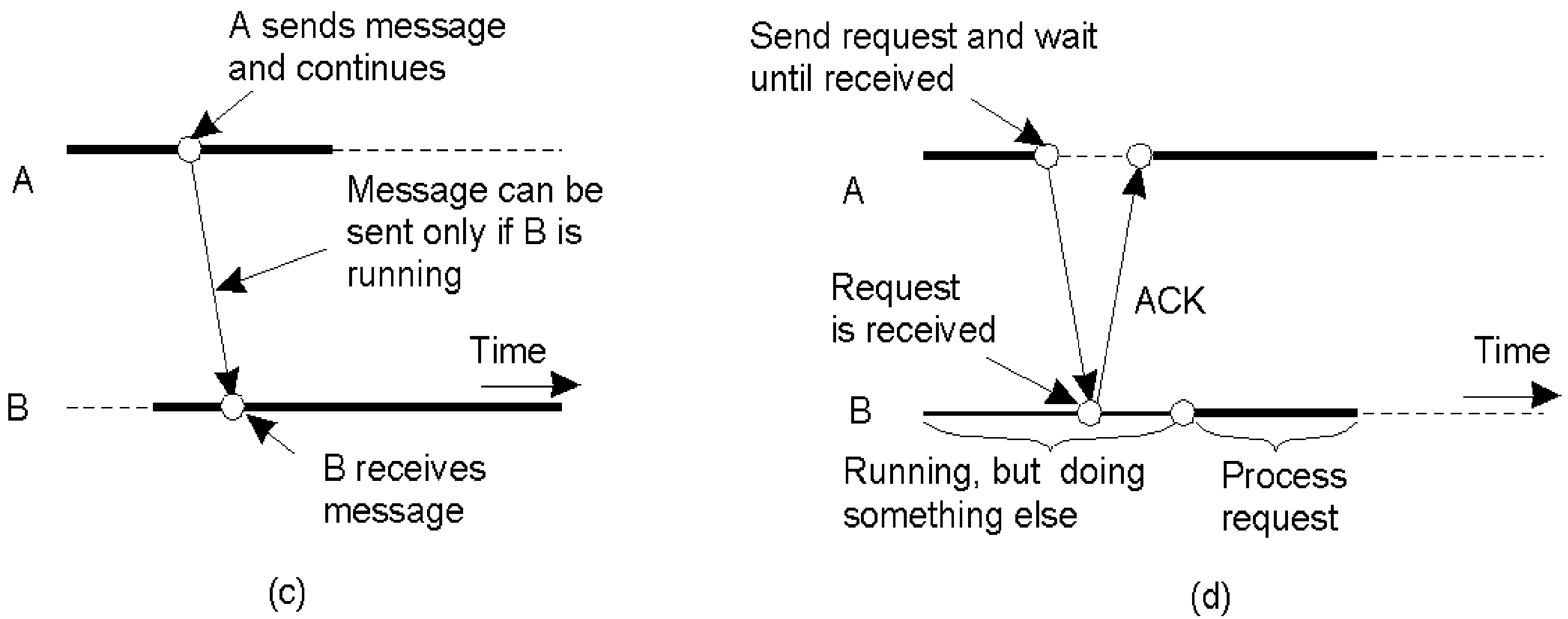
Persistent communication in the days of the Pony Express.

Persistence and Synchronicity (3)



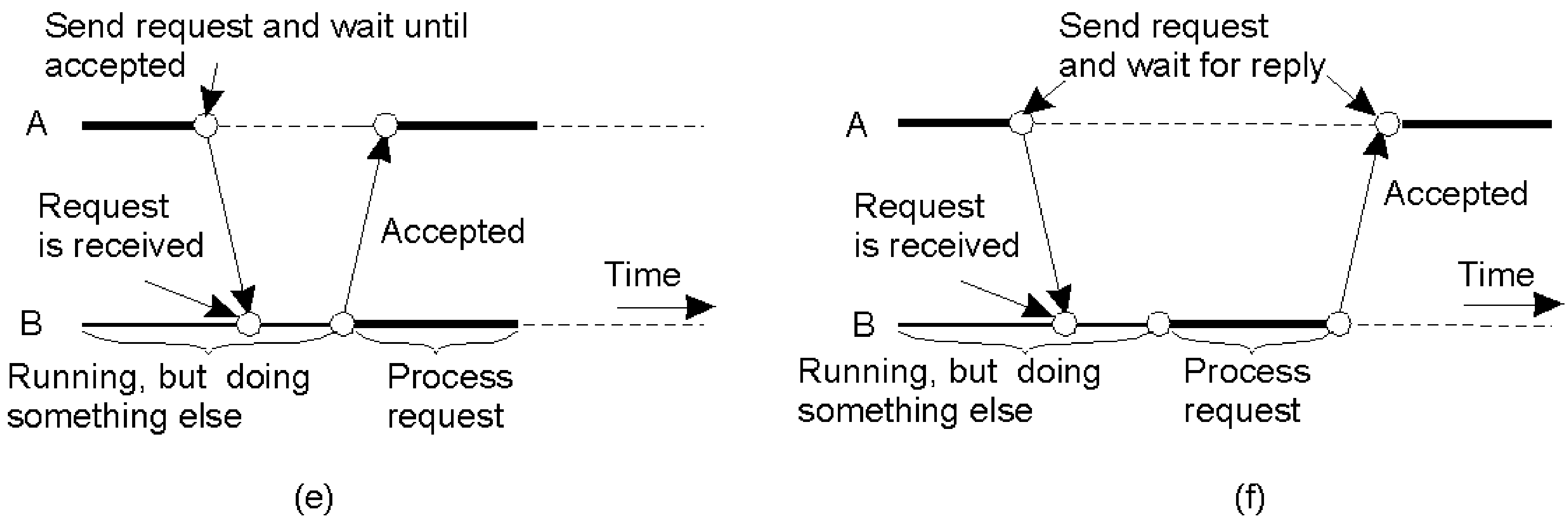
a) Persistent asynchronous communication
b) Persistent synchronous communication

Persistence and Synchronicity (4)



a) Transient asynchronous communication
b) Receipt-based transient synchronous communication

Persistence and Synchronicity (5)



a) Delivery-based transient synchronous communication at message delivery

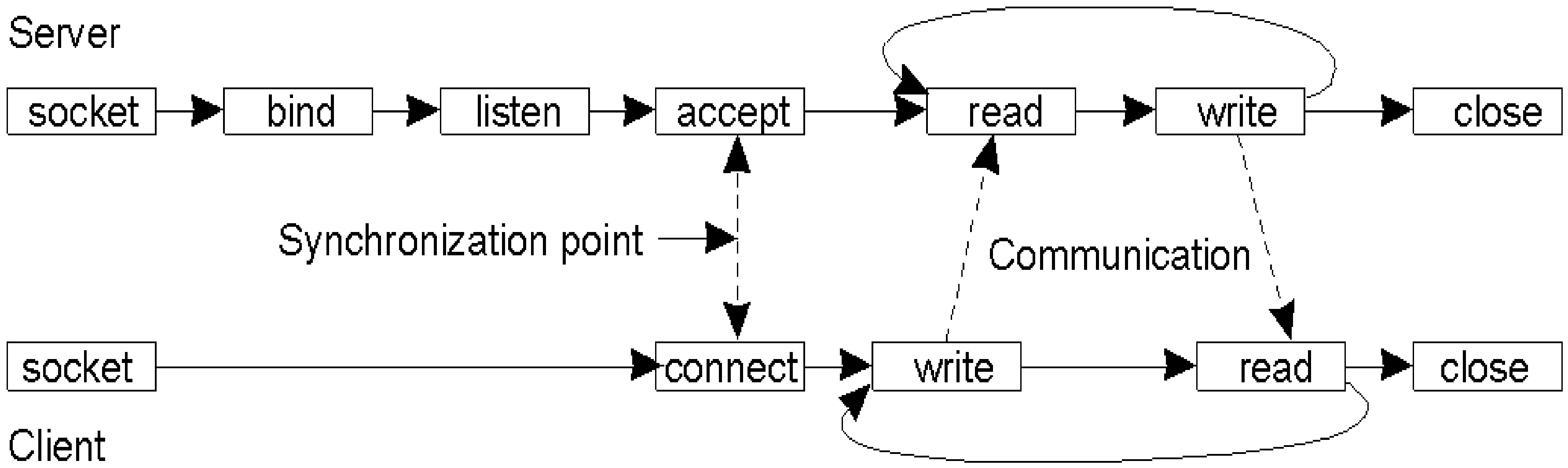
b) Response-based transient synchronous communication

Berkeley Sockets (1)

Primitive	**Meaning**
Socket	Create a new communication endpoint
Bind	Attach a local address to a socket
Listen	Announce willingness to accept connections
Accept	Block caller until a connection request arrives
Connect	Actively attempt to establish a connection
Send	Send some data over the connection
Receive	Receive some data over the connection
Close	Release the connection

Socket primitives for TCP/IP.

Berkeley Sockets (2)



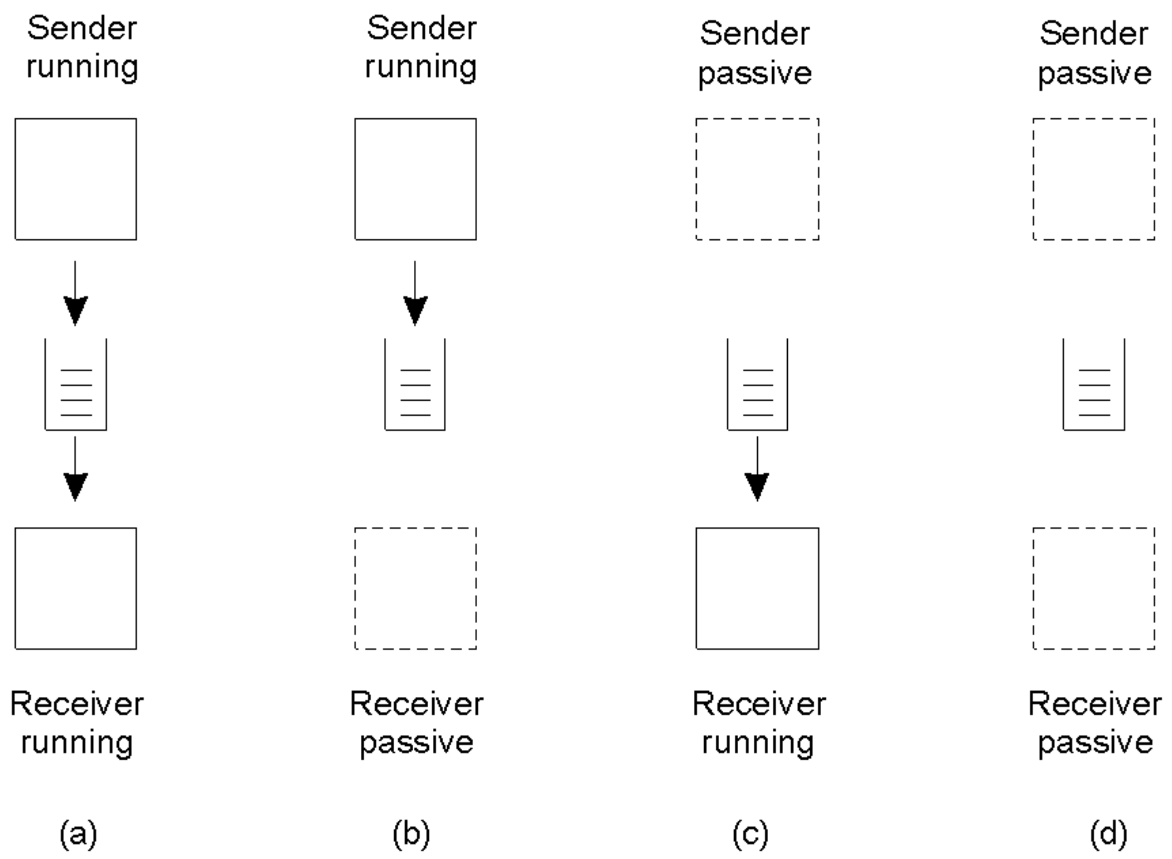
Connection-oriented communication pattern using sockets.

The Message-Passing Interface (MPI)

Primitive	Meaning
MPI_bsend	Append outgoing message to a local send buffer
MPI_send	Send a message and wait until copied to local or remote buffer
MPI_ssend	Send a message and wait until receipt starts
MPI_sendrecv	Send a message and wait for reply
MPI_isend	Pass reference to outgoing message, and continue
MPI_issend	Pass reference to outgoing message, and wait until receipt starts
MPI_recv	Receive a message; block if there are none
MPI_irecv	Check if there is an incoming message, but do not block

Some of the most intuitive message-passing primitives of MPI.

Message-Queuing Model (1)



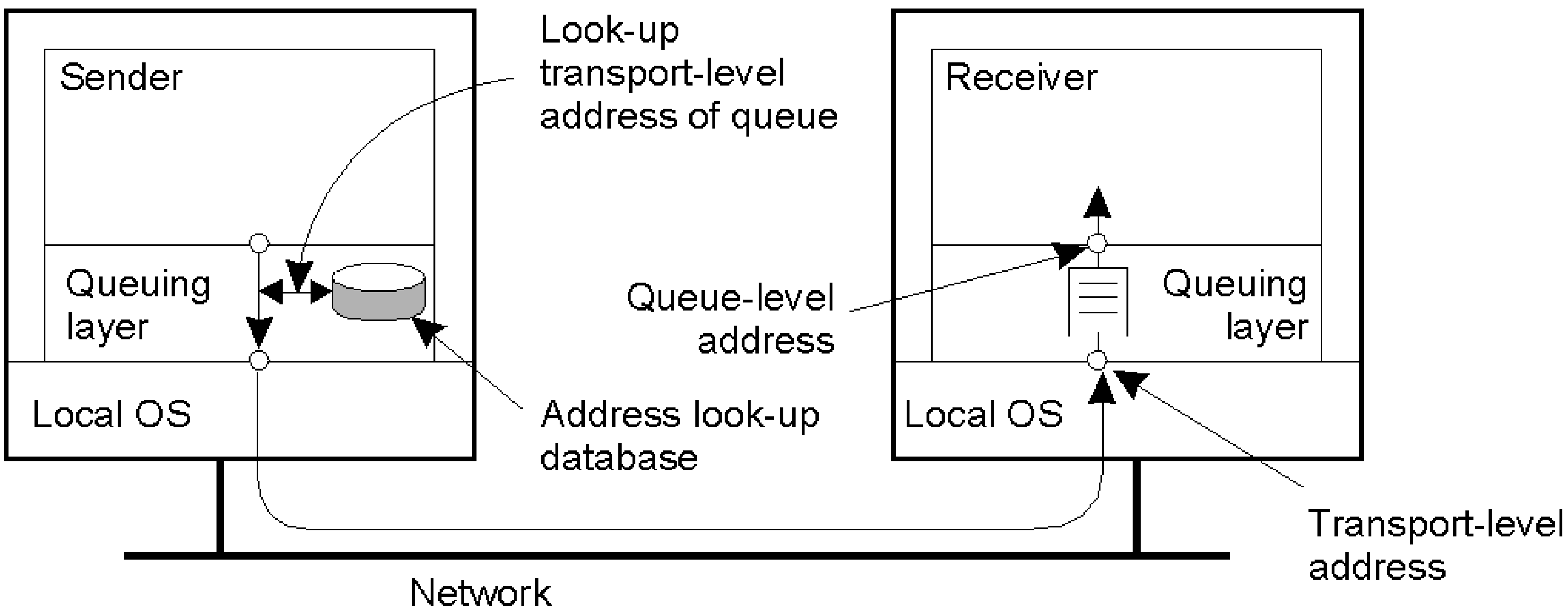
Four combinations for loosely-coupled communications using queues.

Message-Queuing Model (2)

Primitive	**Meaning**
Put	Append a message to a specified queue
Get	Block until the specified queue is nonempty, and remove the first message
Poll	Check a specified queue for messages, and remove the first. Never block.
Notify	Install a handler to be called when a message is put into the specified queue.

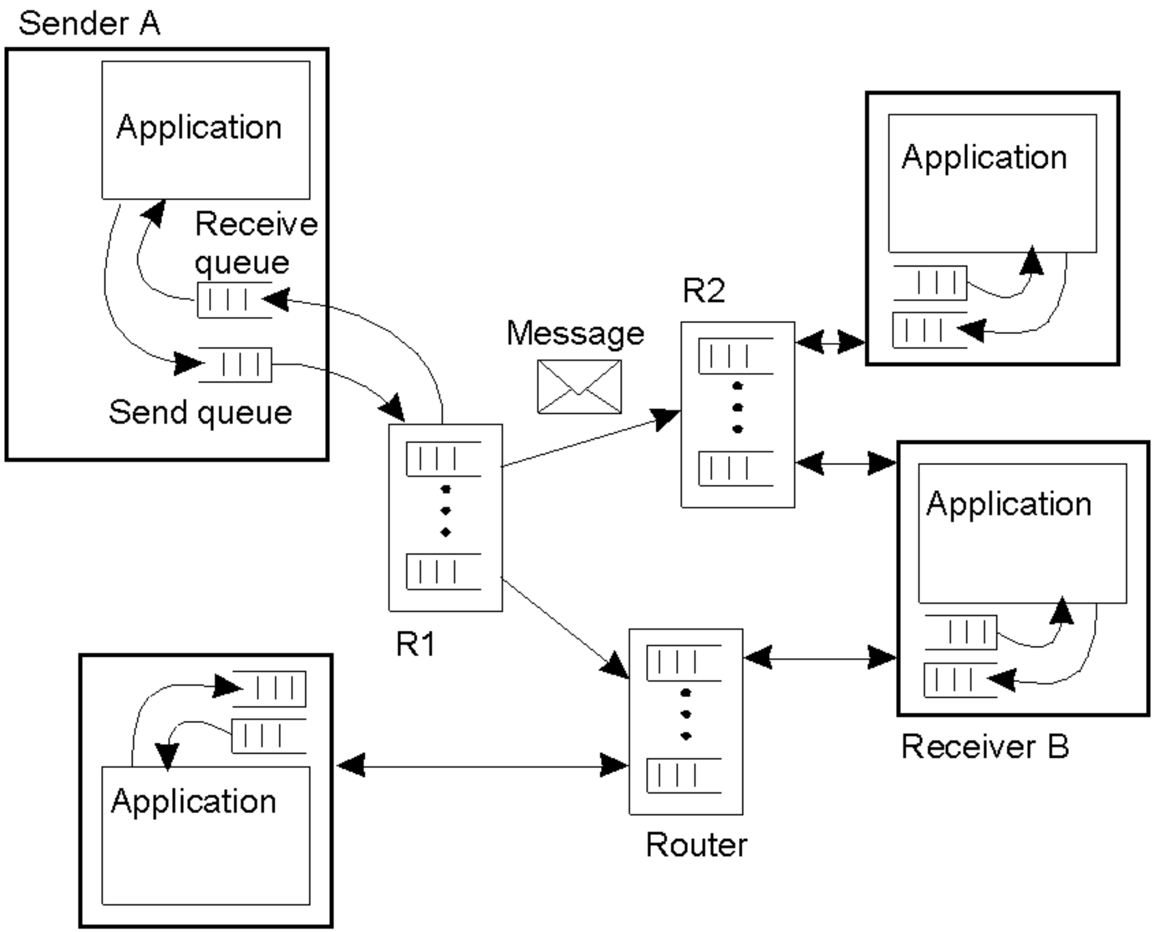
Basic interface to a queue in a message-queuing system.

General Architecture of a Message-Queuing System (1)



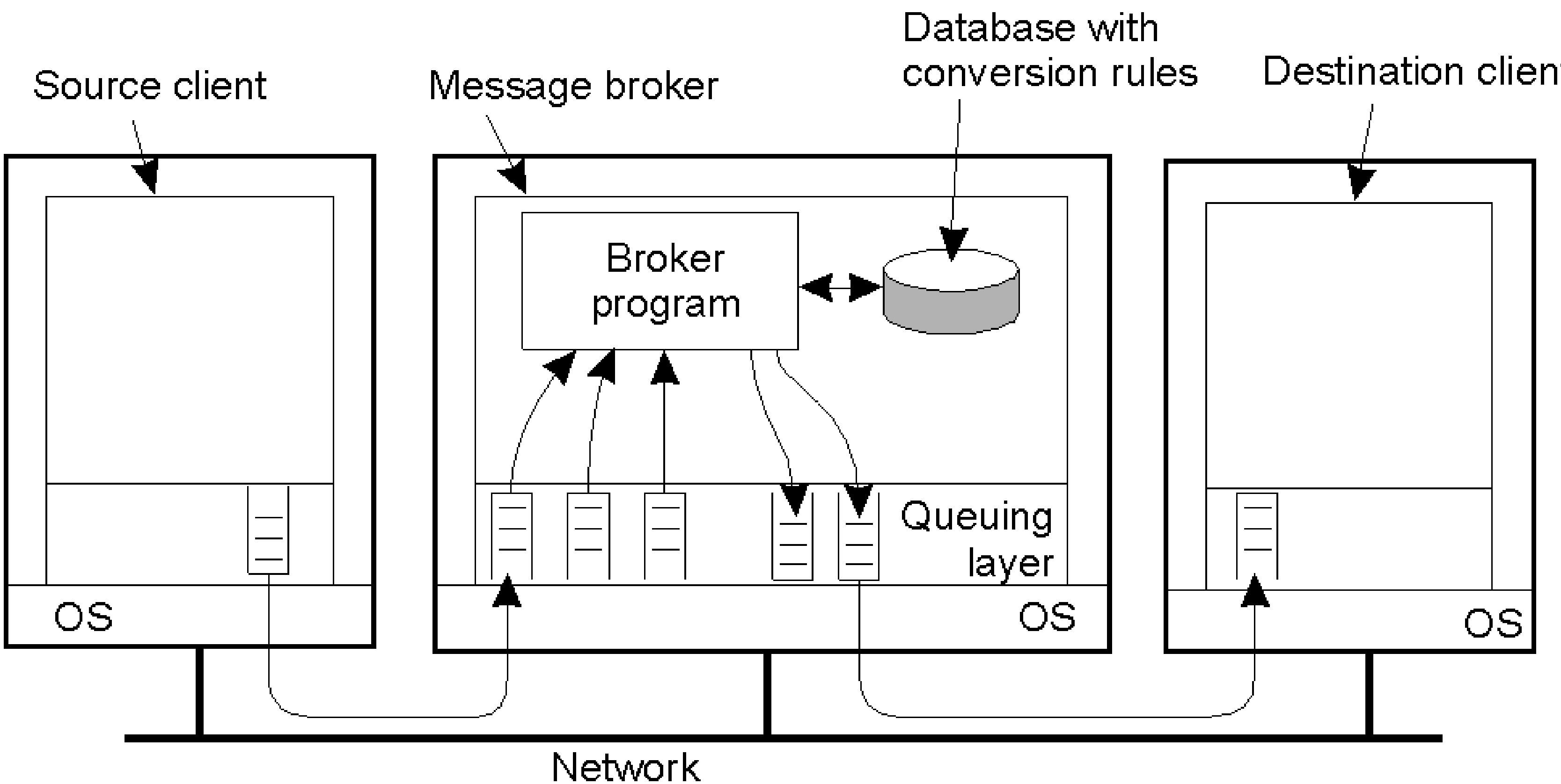
The relationship between queue-level addressing and network-level addressing.

General Architecture of a Message-Queuing System (2)

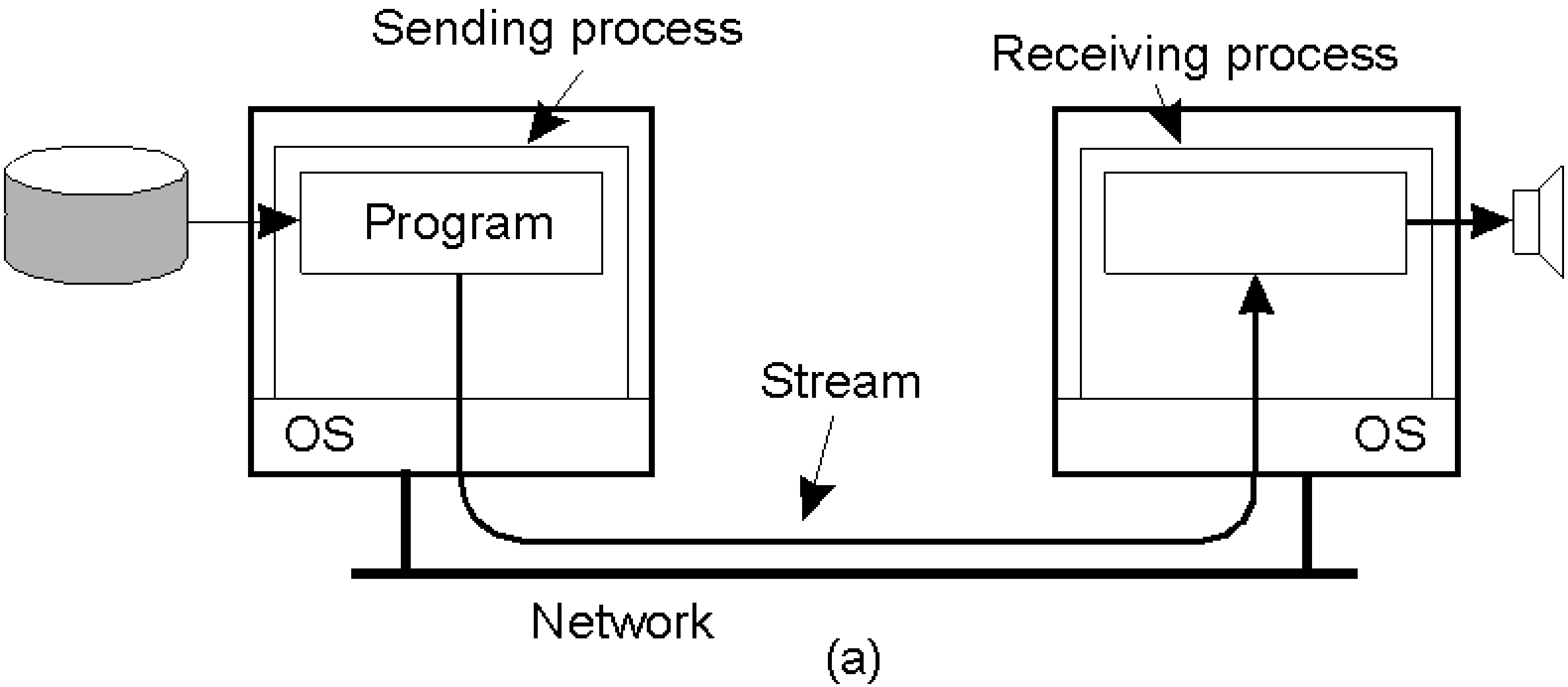


Organization of a message-queuing system with routers.

Message Brokers

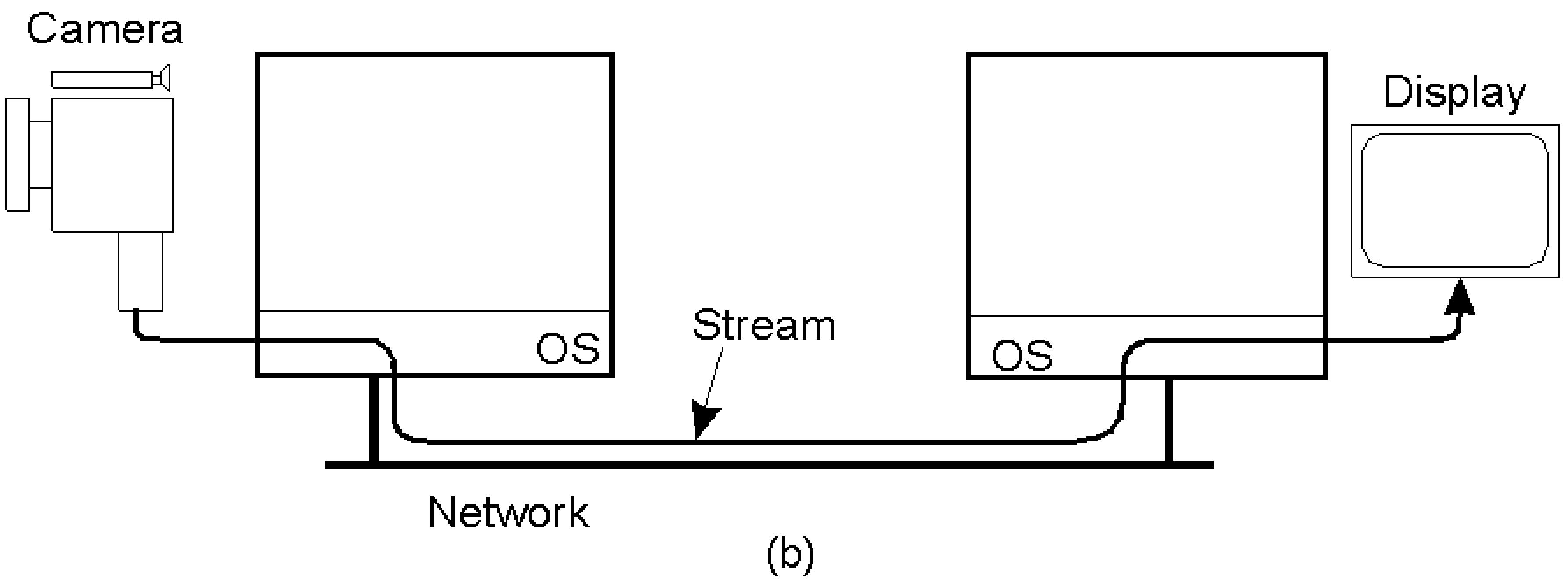


Data Stream (1)



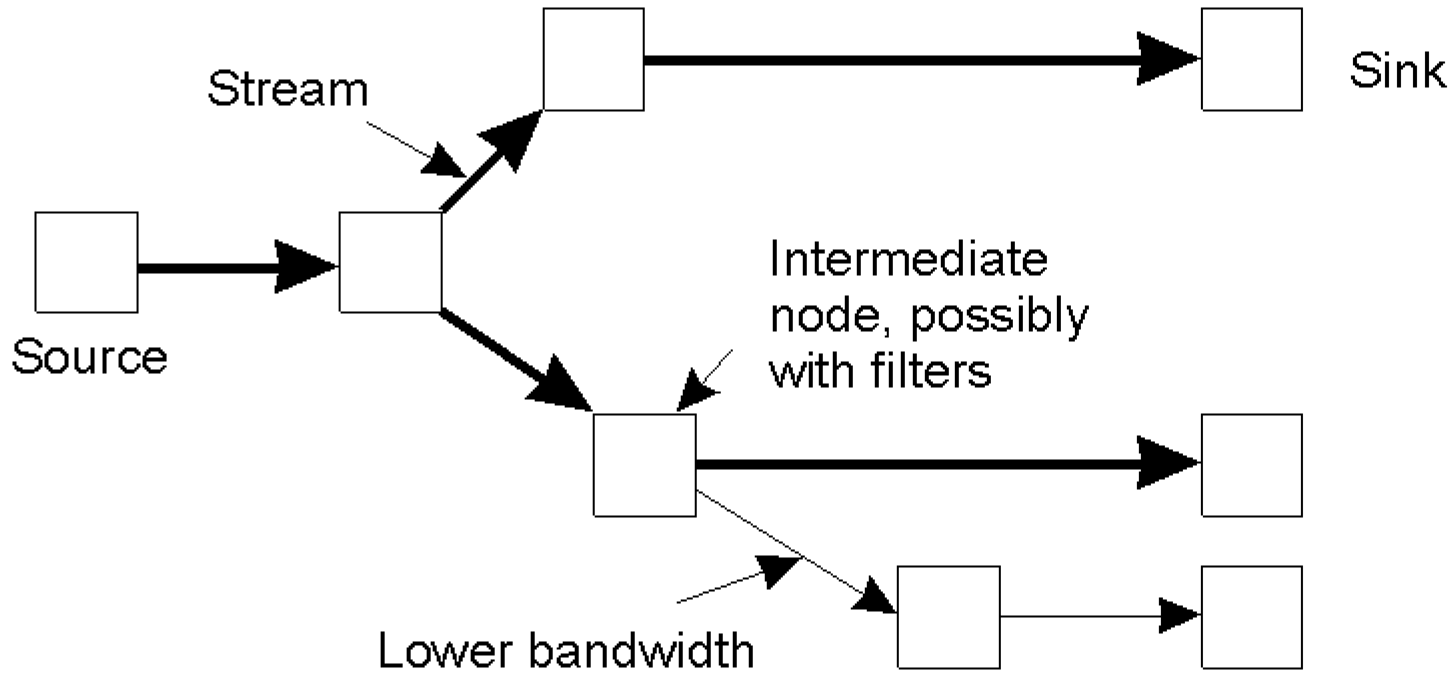
Setting up a stream between two processes across a network.

Data Stream (2)



Setting up a stream directly between two devices.

Data Stream (3)



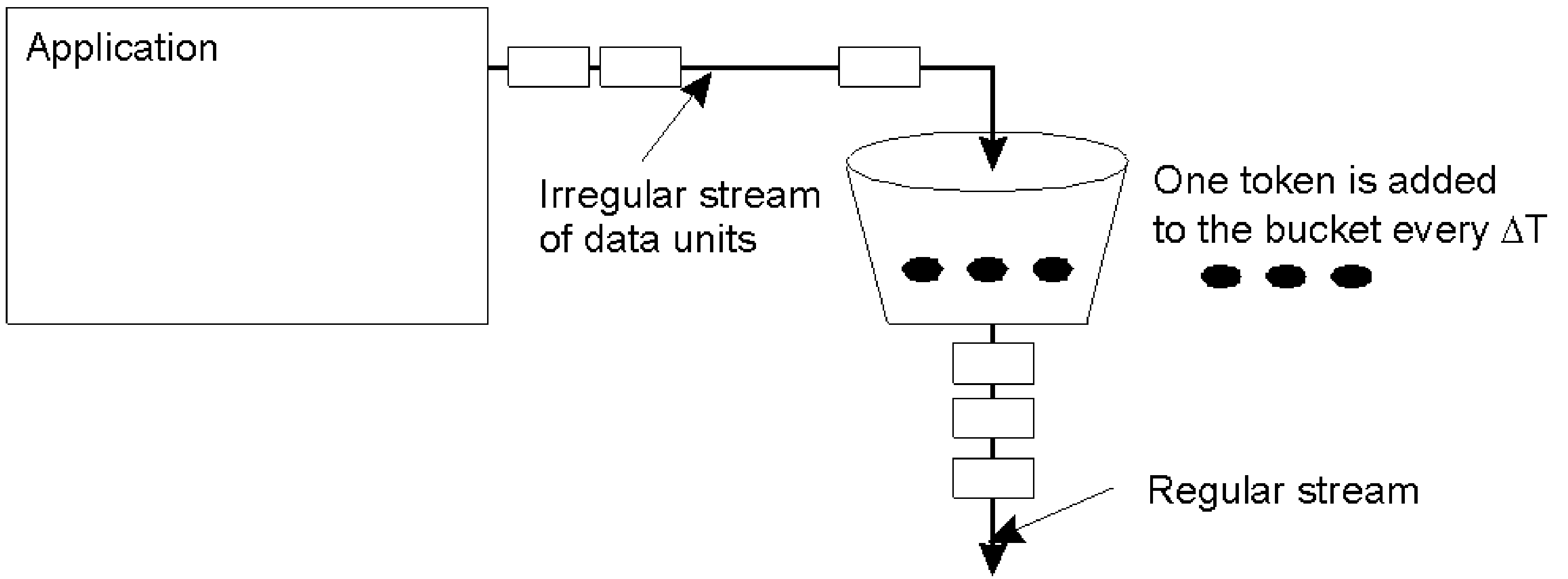
An example of multicasting a stream to several receivers.

Specifying QoS (1)

Characteristics of the Input	**Service Required**
• maximum data unit size (bytes) • Token bucket rate (bytes/sec) • Toke bucket size (bytes) • Maximum transmission rate (bytes/sec)	• Loss sensitivity (bytes) • Loss interval (μsec) • Burst loss sensitivity (data units) • Minimum delay noticed (μsec) • Maximum delay variation (μsec) • Quality of guarantee

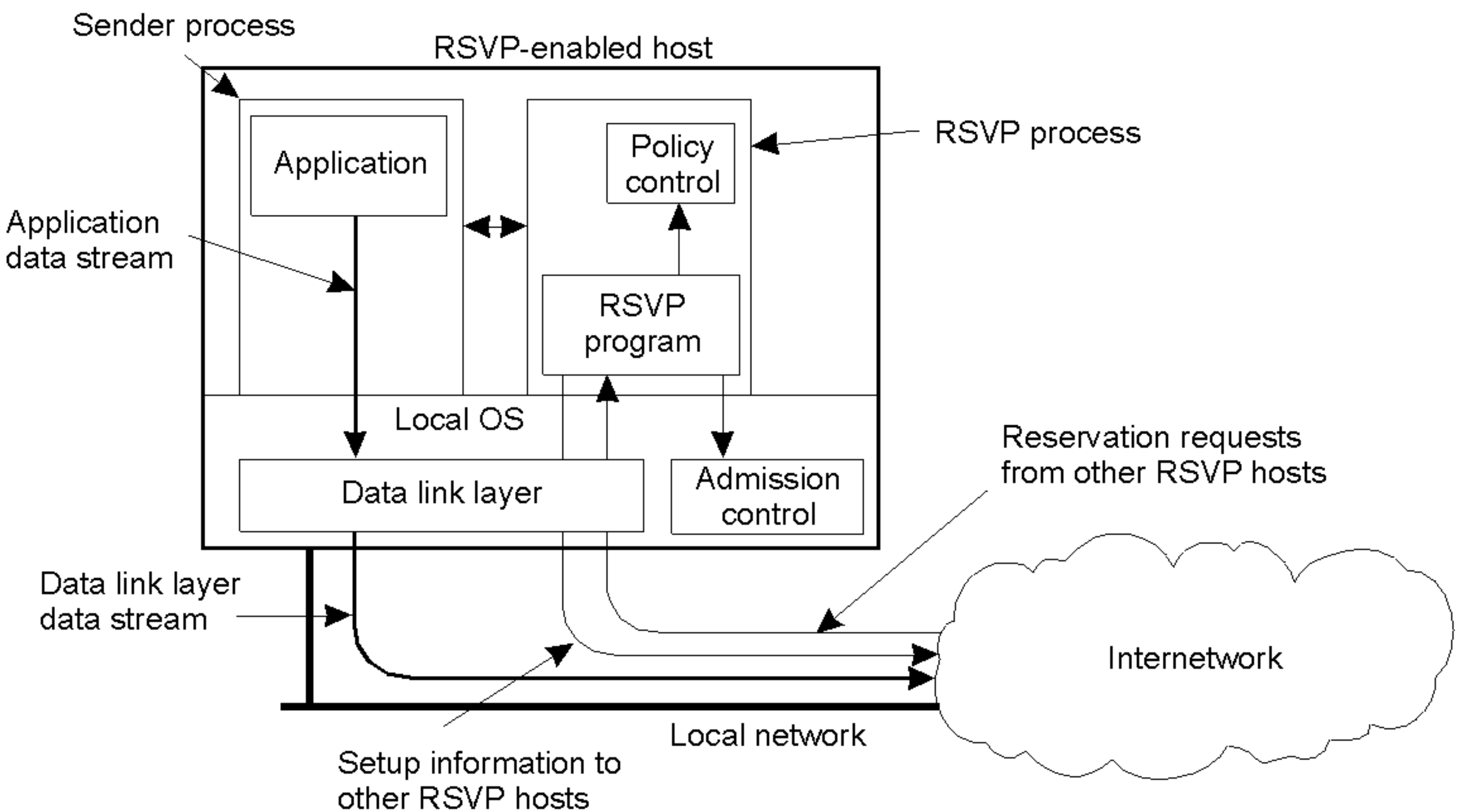
A flow specification.

Specifying QoS (2)



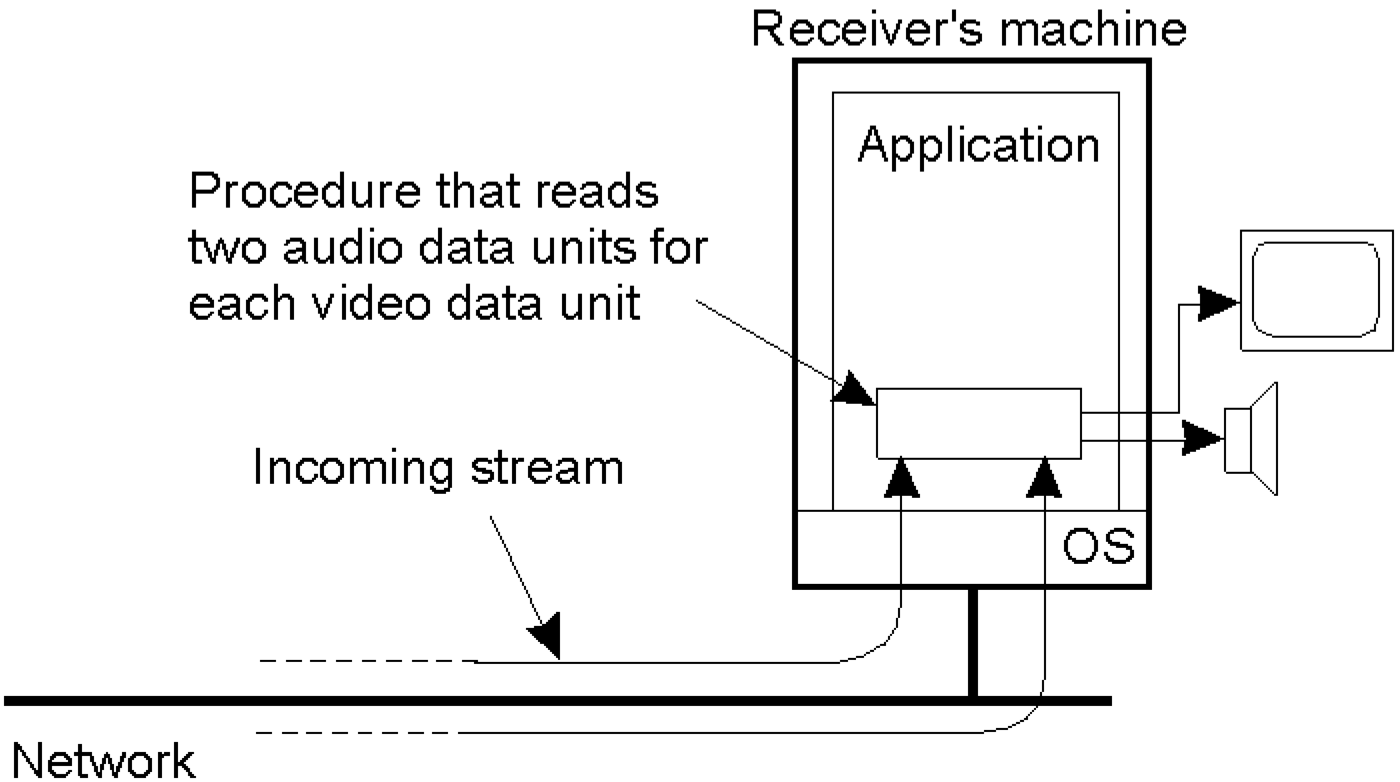
The principle of a token bucket algorithm.

Setting Up a Stream



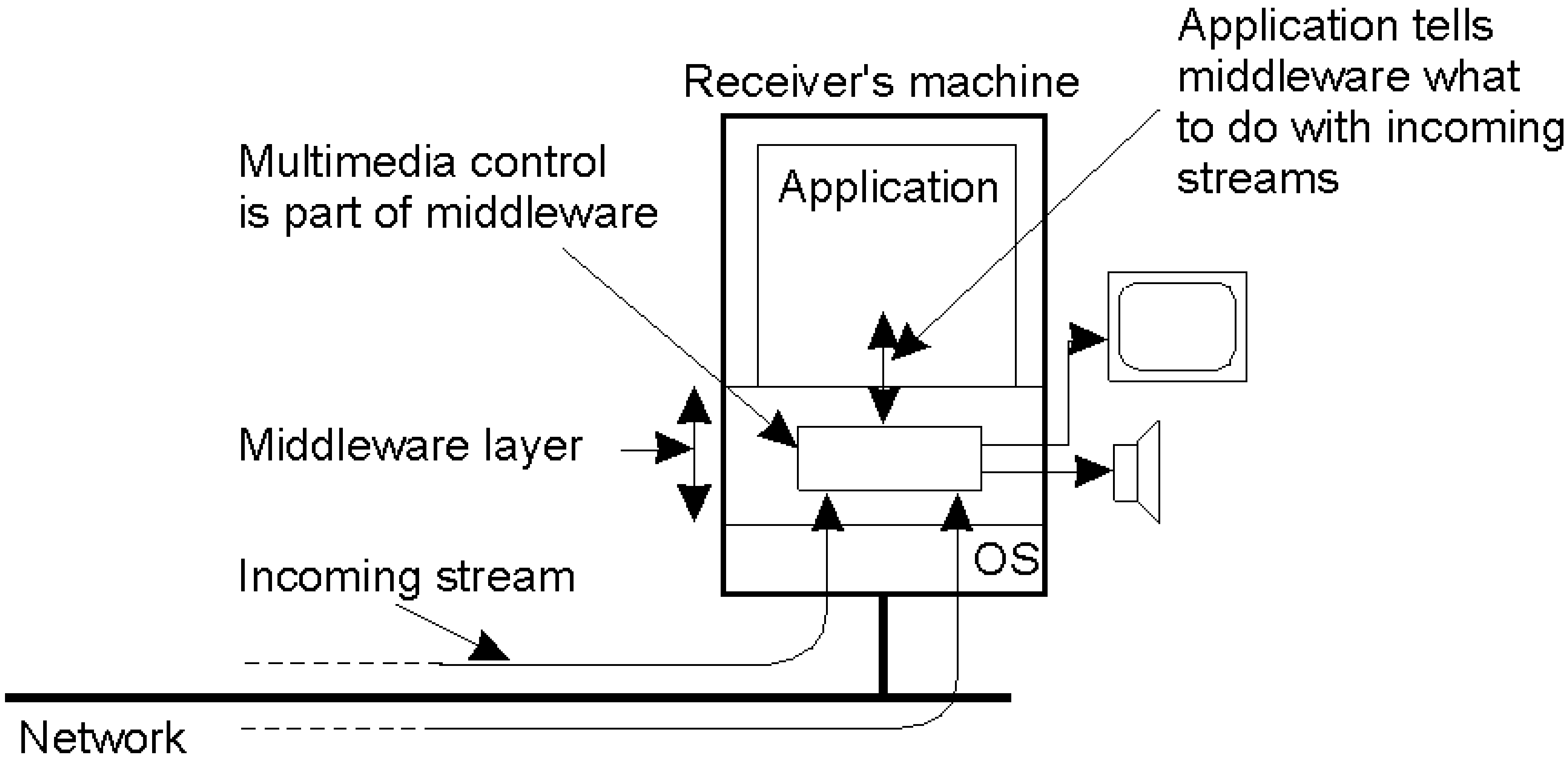
The basic organization of RSVP for resource reservation in a distributed system.

Synchronization Mechanisms (1)



The principle of explicit synchronization on the level data units.

Synchronization Mechanisms (2)



The principle of synchronization as supported by high-level interfaces.

Multicasting

Transport or application level

Distribution trees

Gossip

Level

Multicast in Network Protocols:

- Creating *communication paths*
- Enormous management effort
- ISP reluctant to implement

Multicast at the Application Level

- Has become possible in the age of P2P
- *Communication paths* as *overlay networks*
- Two techniques:
  - explicit communication paths
  - gossiping

Application-Level Multicasting

Basic idea: nodes organized in an *overlay network*

N.B.: *routers* are not part of the overlay network!

Basic design element: overlay network construction

Two approaches are possible:

- Distribution tree layout
- Mesh layout (multiple paths are possible)

Multicast Tree Construction

Method used in the CHORD system (DHT):

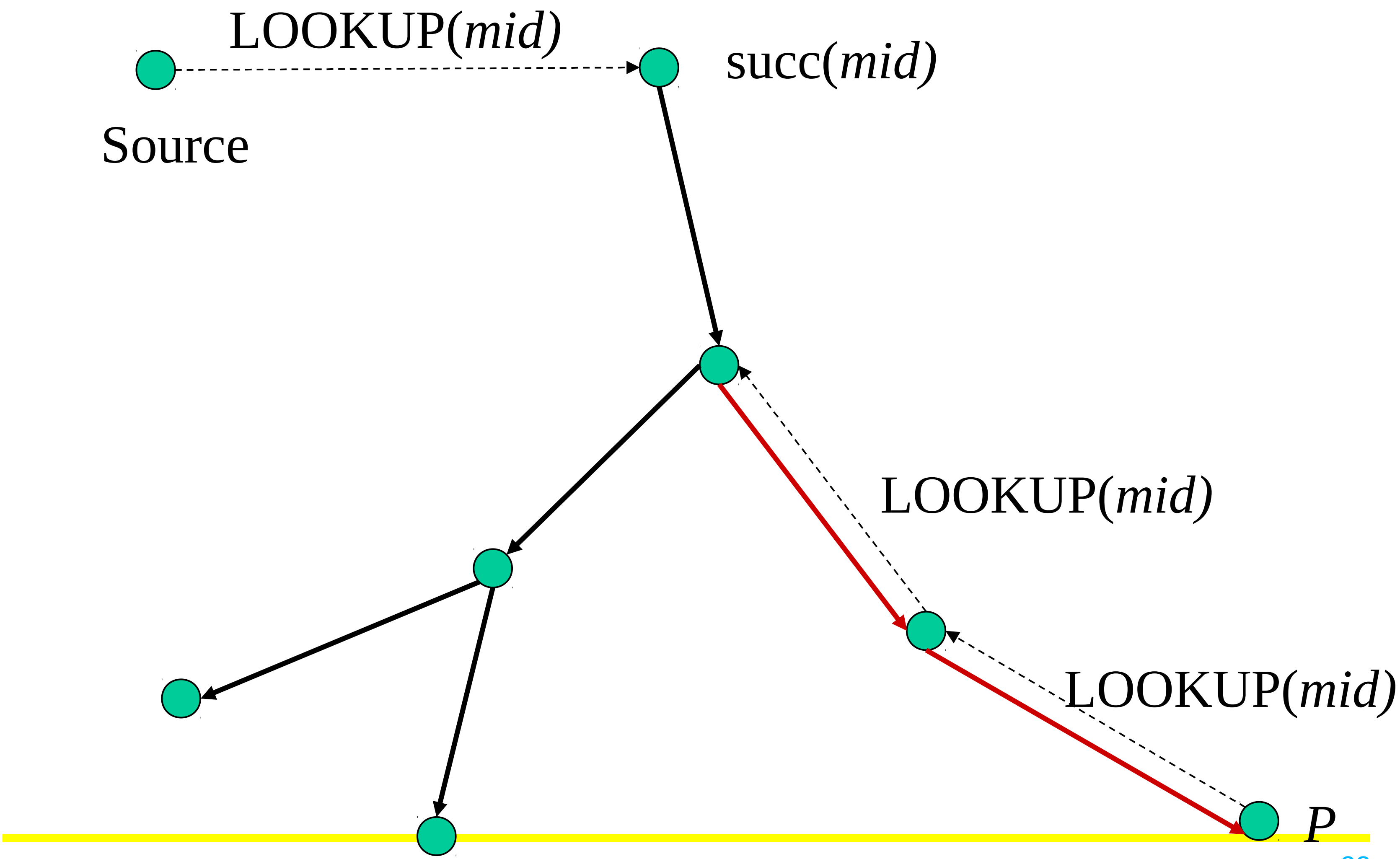
– The node that initiates a multicast session generates a 160 bit random identifier, *mid*;

– Look succ(*mid*) up and make it the tree root;

– If a node *P* wishes to “register” to the tree, it sends a message to succ(*mid*), which will go through other nodes

– The nodes traversed either are already in the tree, or they become *forwarders* on behalf of *P*.

Multicast Tree Construction



Quality of a Multicast Tree

Link Stress:

– How many times the same packet goes through the same link

Stretch or relative delay penalty (RDP)

– $d_{\text{overlay}}(A, B)/d_{\text{phis}}(A, B) \geq 1$

Cost of the Tree

– A global measure, relevant to controlling the resources used by multicast communication

Information Diffusion Models

Epidemic Behavior

Information spreads “by contagion”

- *Infected node* = has the data that have to be spread
- *Susceptible node* = does not have the data
- *Removed node* = has the data but it does not spread them

Fully Local Techniques

Anti-Entropy

P randomly picks another node *Q*

Three possible approaches:

1. *Push: P* sends its data to *Q*
2. *Pull: P* requests data from *Q*
3. *Push-Pull: P and Q* exchange data

Push approach is inefficient

Push-pull approach is optimal

All nodes get updated in $O(\log N)$ “rounds”.

Gossiping

When node *P* gets to know some new information, it starts contacting other arbitrary nodes (random, neighbors, ...) to tell them.

Every time a contacted node turns out to already know, with probability $1/k$, *P* decides to give up “gossiping” and becomes “removed”.

Problem: the fraction of “susceptible” nodes tends to

$s = \exp[-(k + 1)(1 - s)]$

Data Elimination

A problem, because, if data are removed, a node becomes again susceptible

“Deat Certificate” technique

These to have to be eliminated, after a while:

“Inactive Death Certificates”

Merci de votre attention