Logical Mobility and Physical Mobility

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What is a Process?

- A process is an active entity and is defined as a program in execution.
- A process consists of data, a stack, register contents, and the state specific to the underlying Operating System (OS), such as parameters related to process, memory, device and file management.
- A process can be categorized as a system process or an application process. Figure 1 shows the system process layout of a typical Distributed Operating System (DOS).

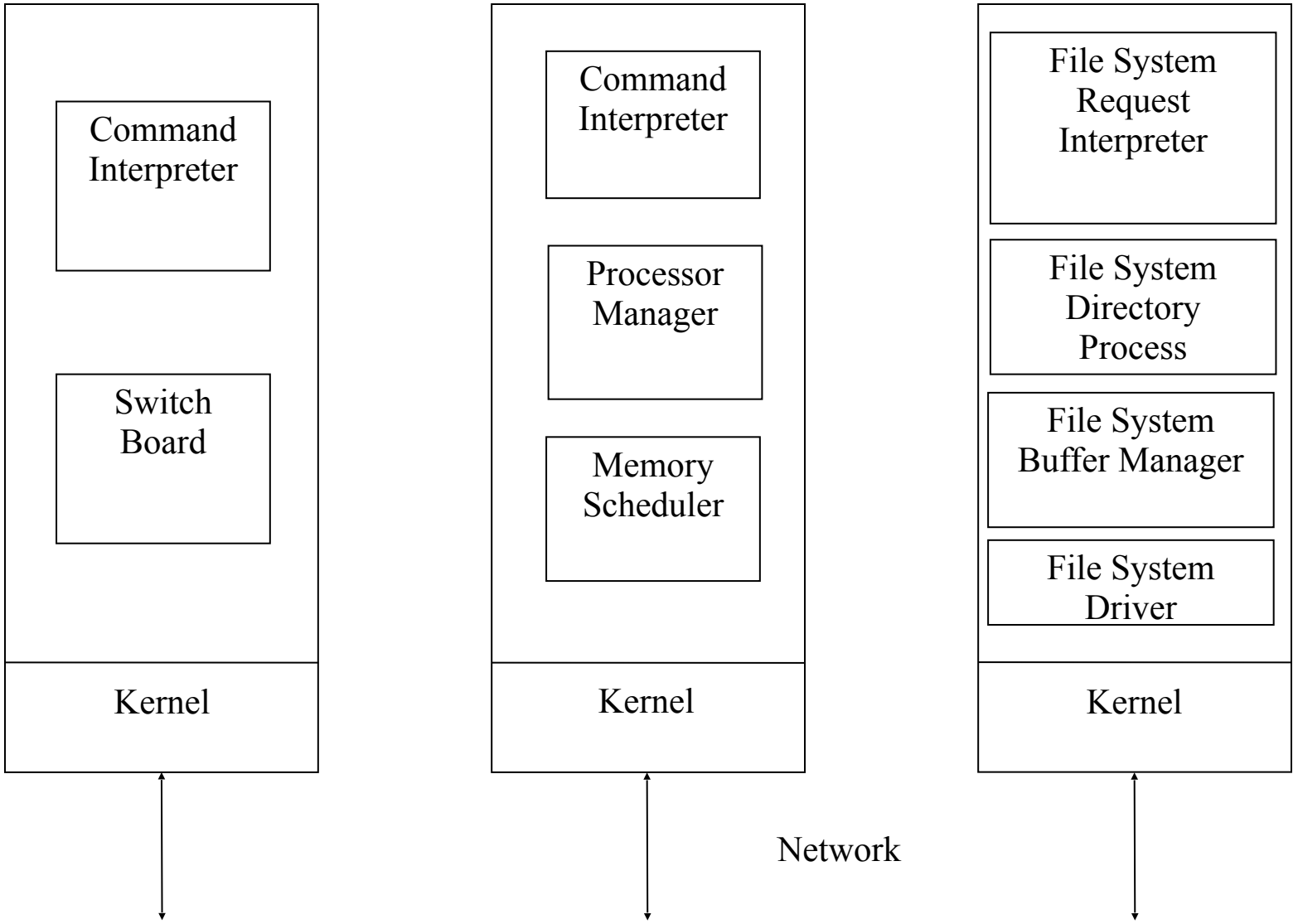


Figure 1 System process layout in a DOS

Process Migration

Process migration consists of extracting the state of the process on the source node, transferring it to the destination node where a new instance of the process is created, and updating the connections with other processes on communicating nodes, as shown in Figure 2.

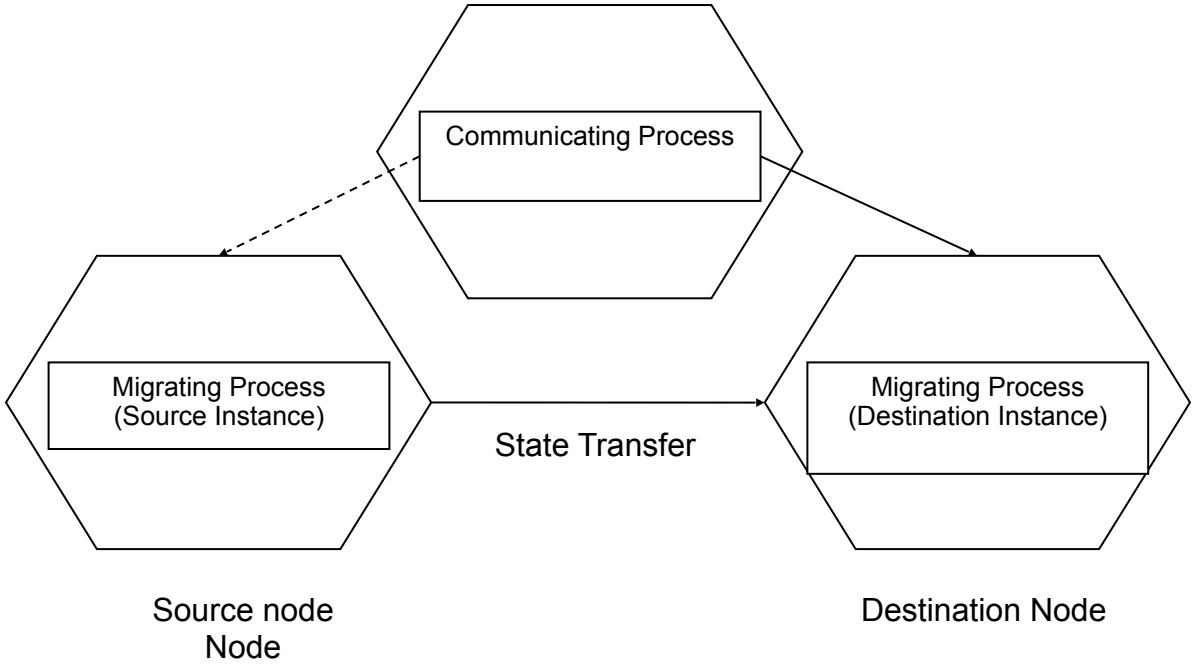


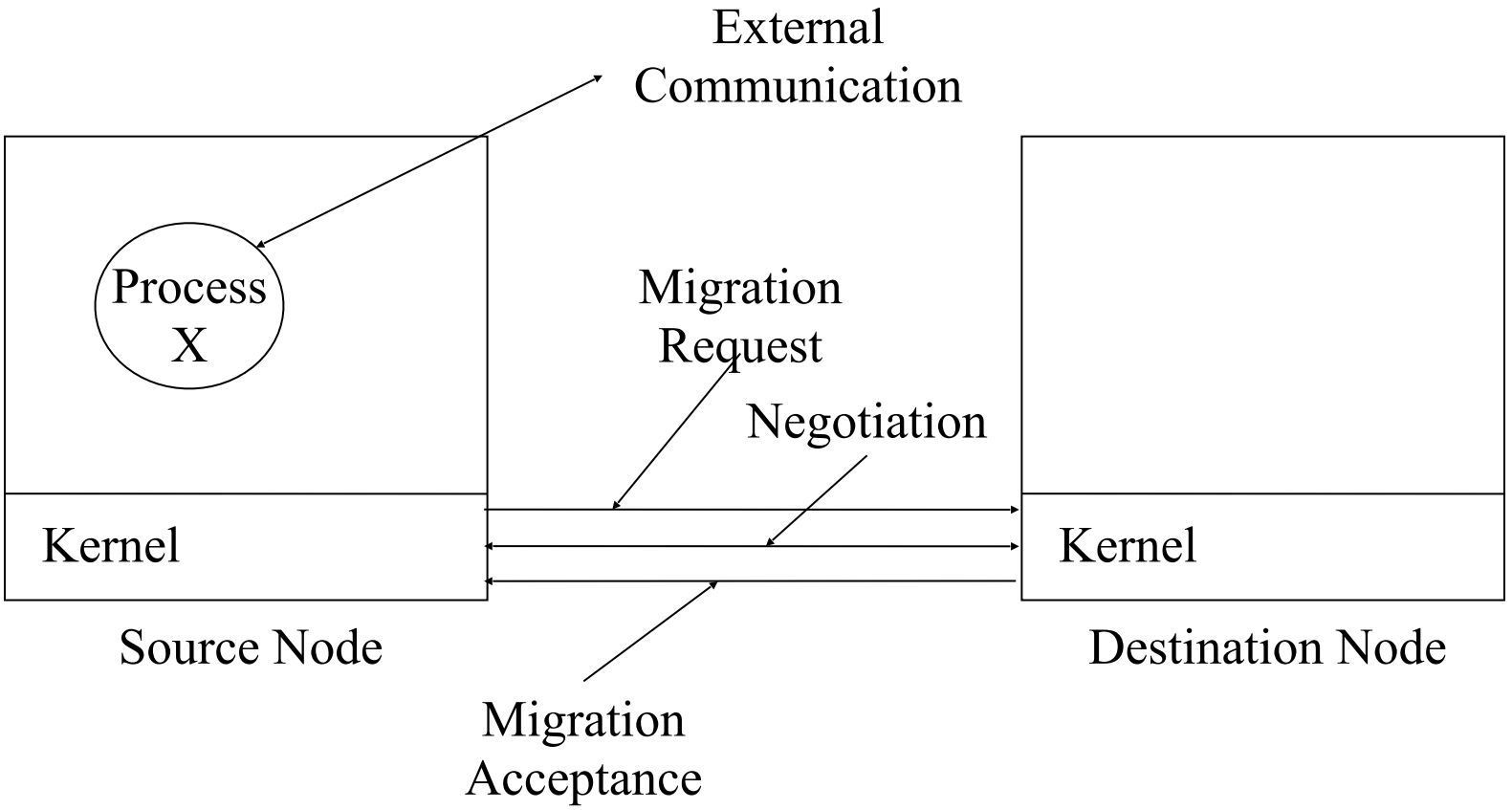
Figure 2 High level view of migration

Steps in Process Migration

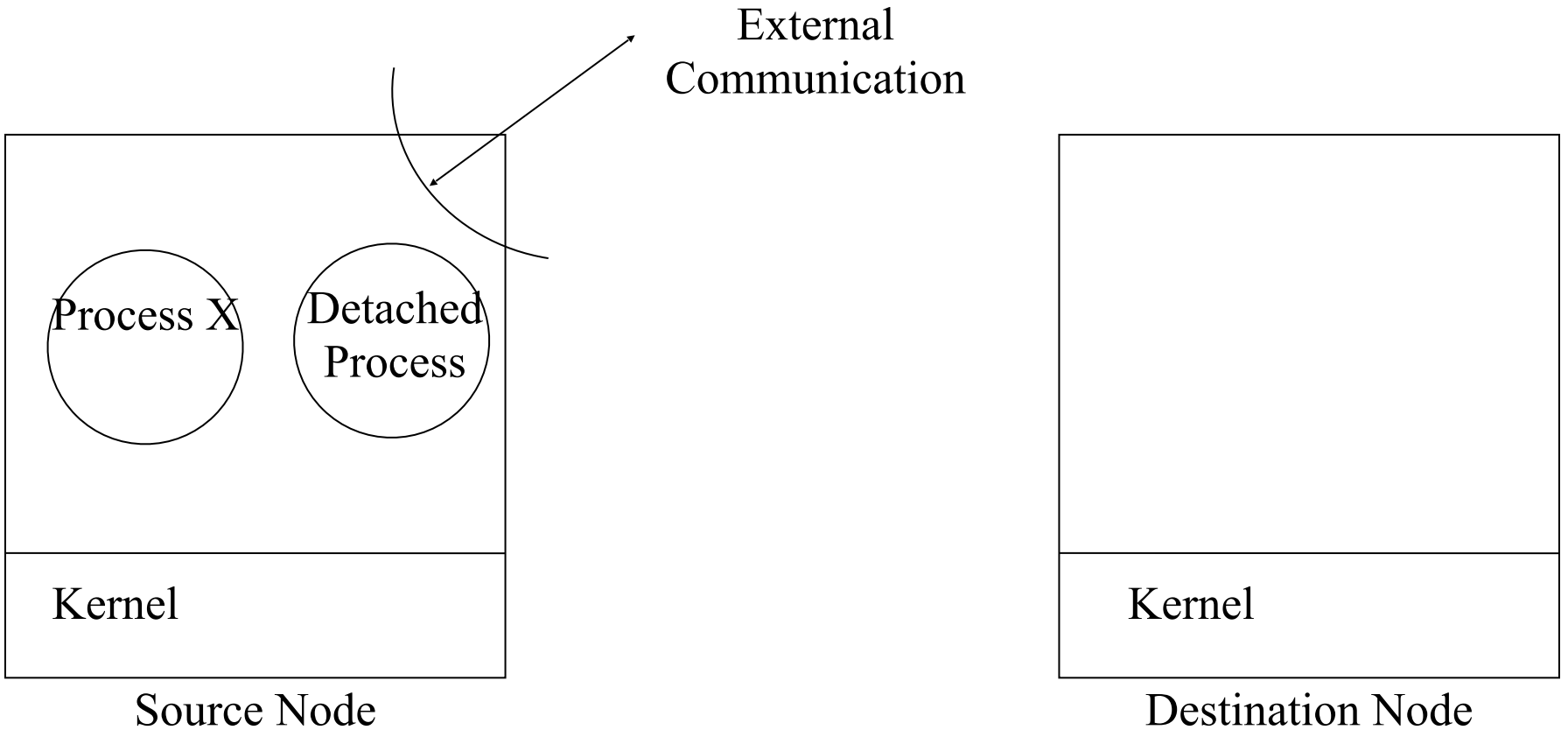
These steps are shown pictorially in Figures 1) to 8).

1. A migration request is issued to a remote node
2. A process is detached from its source node
3. Communication is temporarily redirected
4. The process state is extracted
5. A destination process instance is created
6. State is transferred and imported into a new instance
7. Some means of forwarding references
8. The new instance is resumed

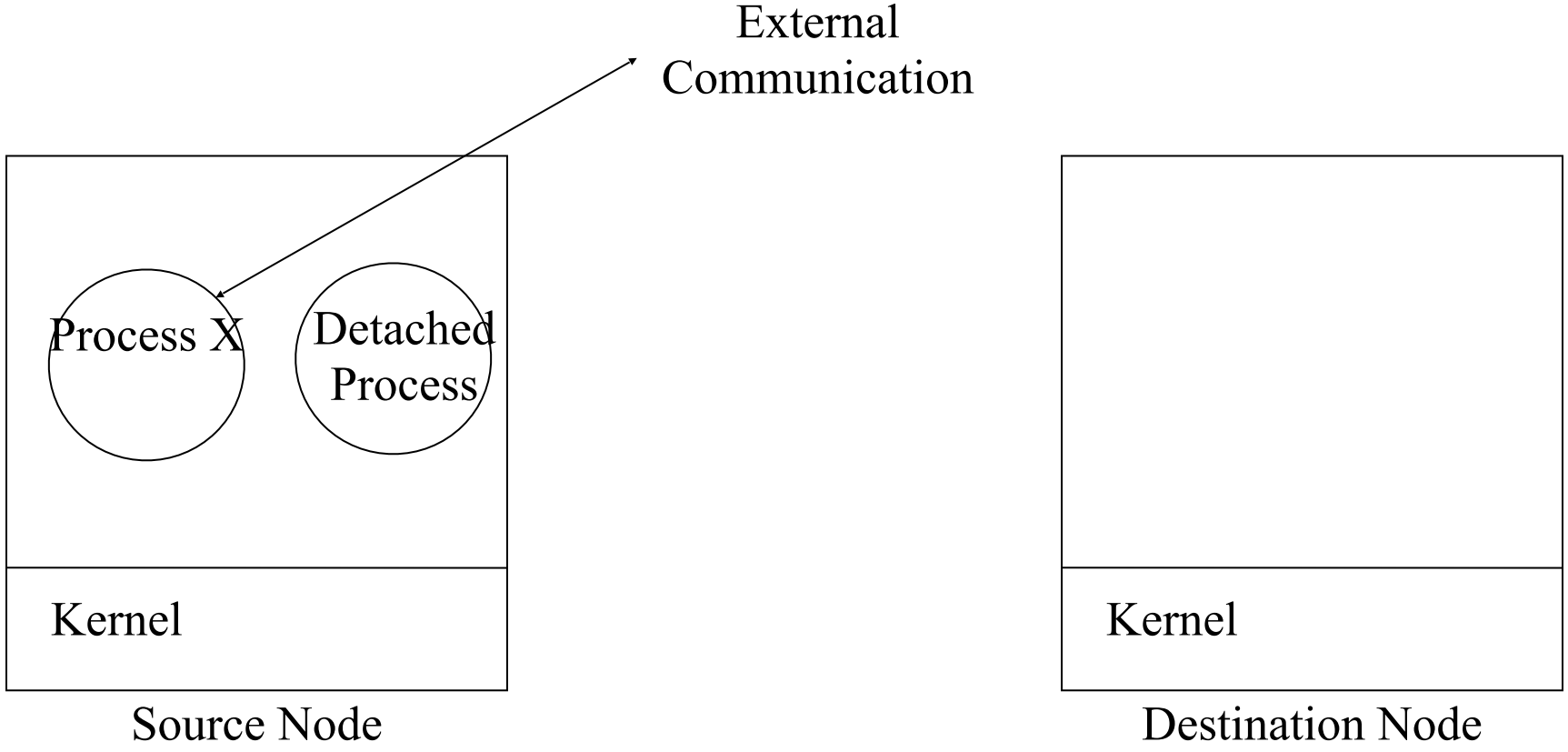
1- A migration request is issued to a remote node After negotiation, migration has been accepted.



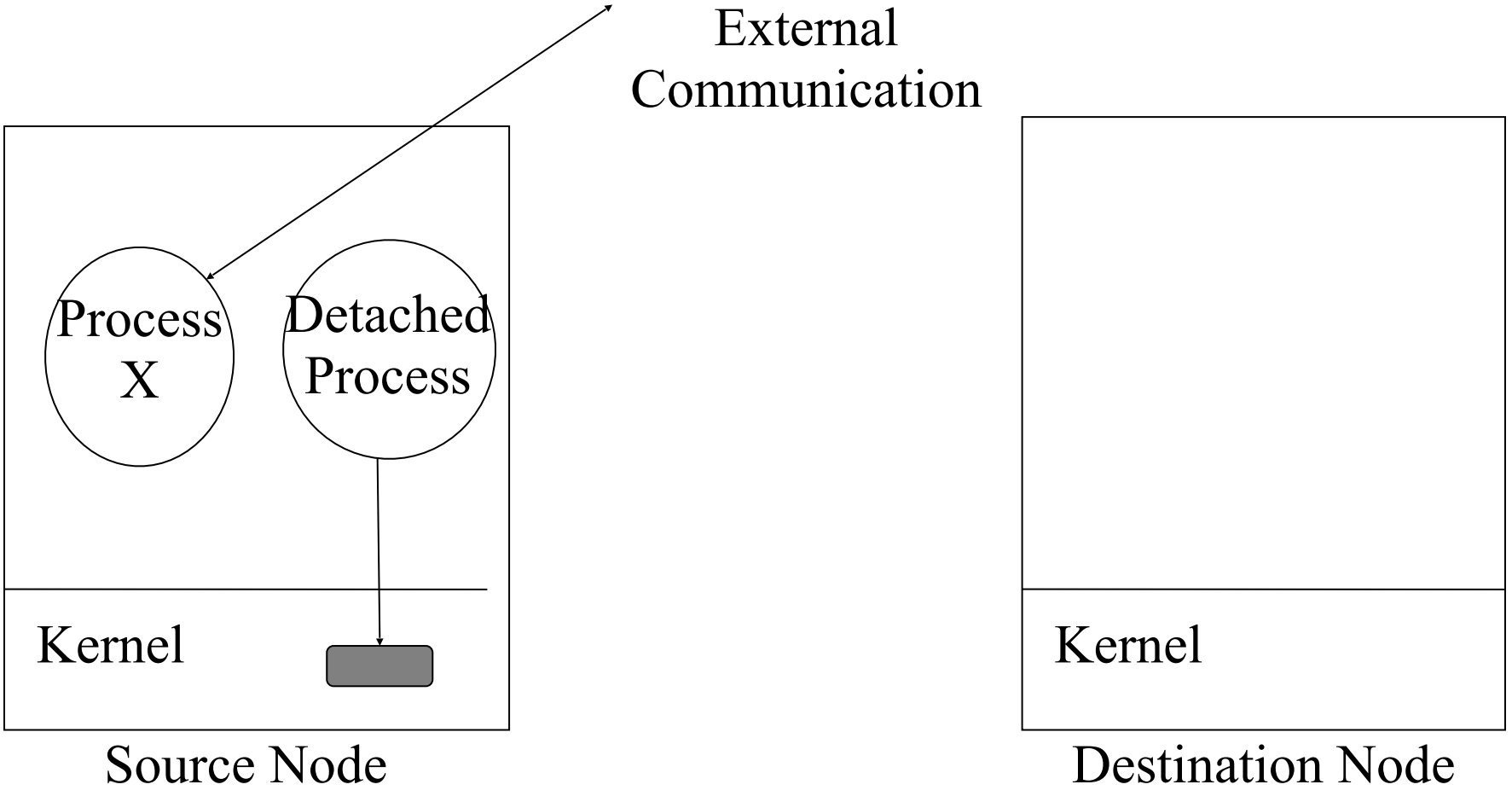
2-A process is detached from its source node by suspending its execution, declaring it to be in a migrating state, and temporarily redirecting communication as given in the following step.



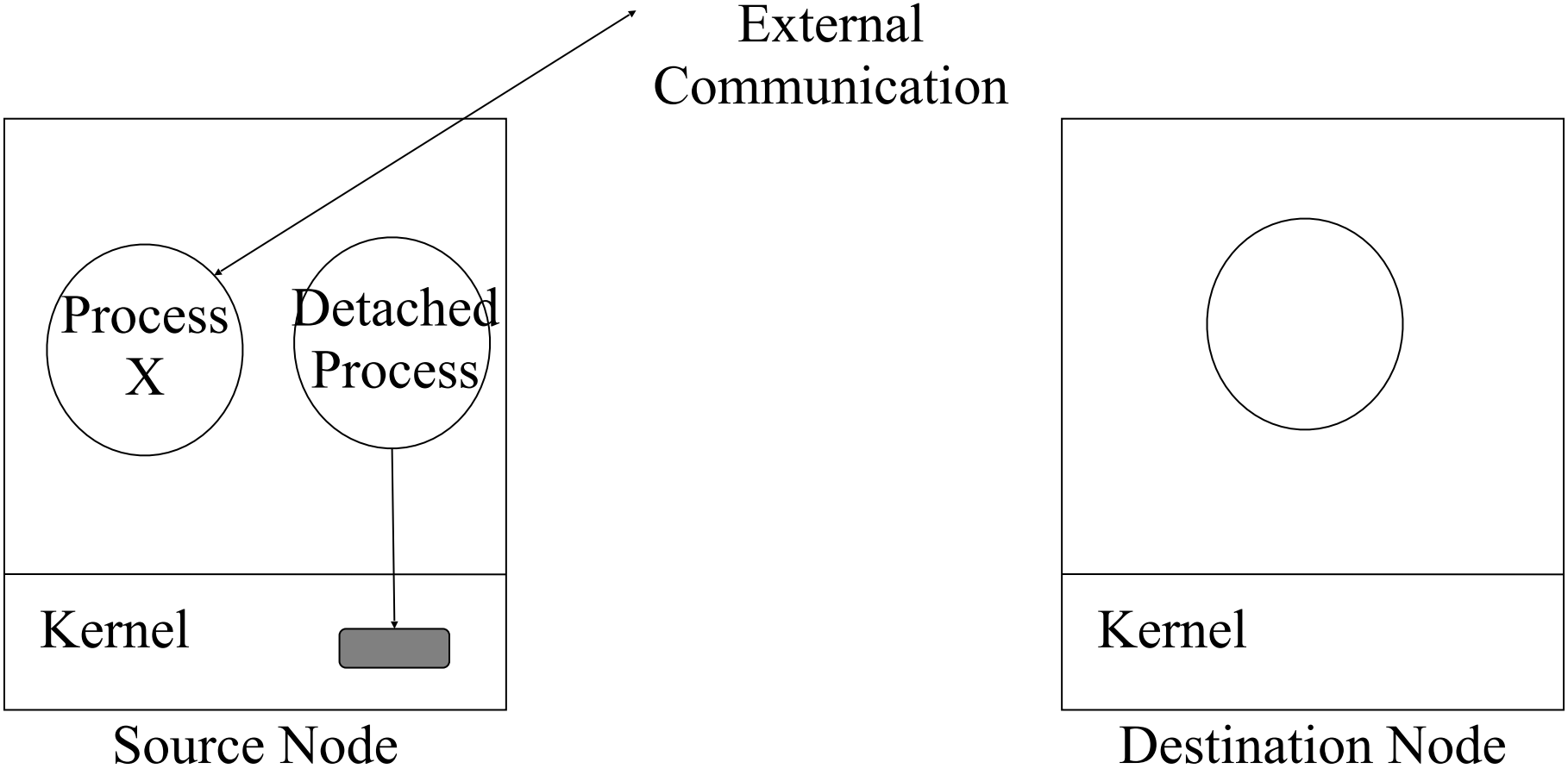
3 - Communication is temporarily redirected by queuing up arriving messages directed to the migrated process. These are delivered to the process after migration.



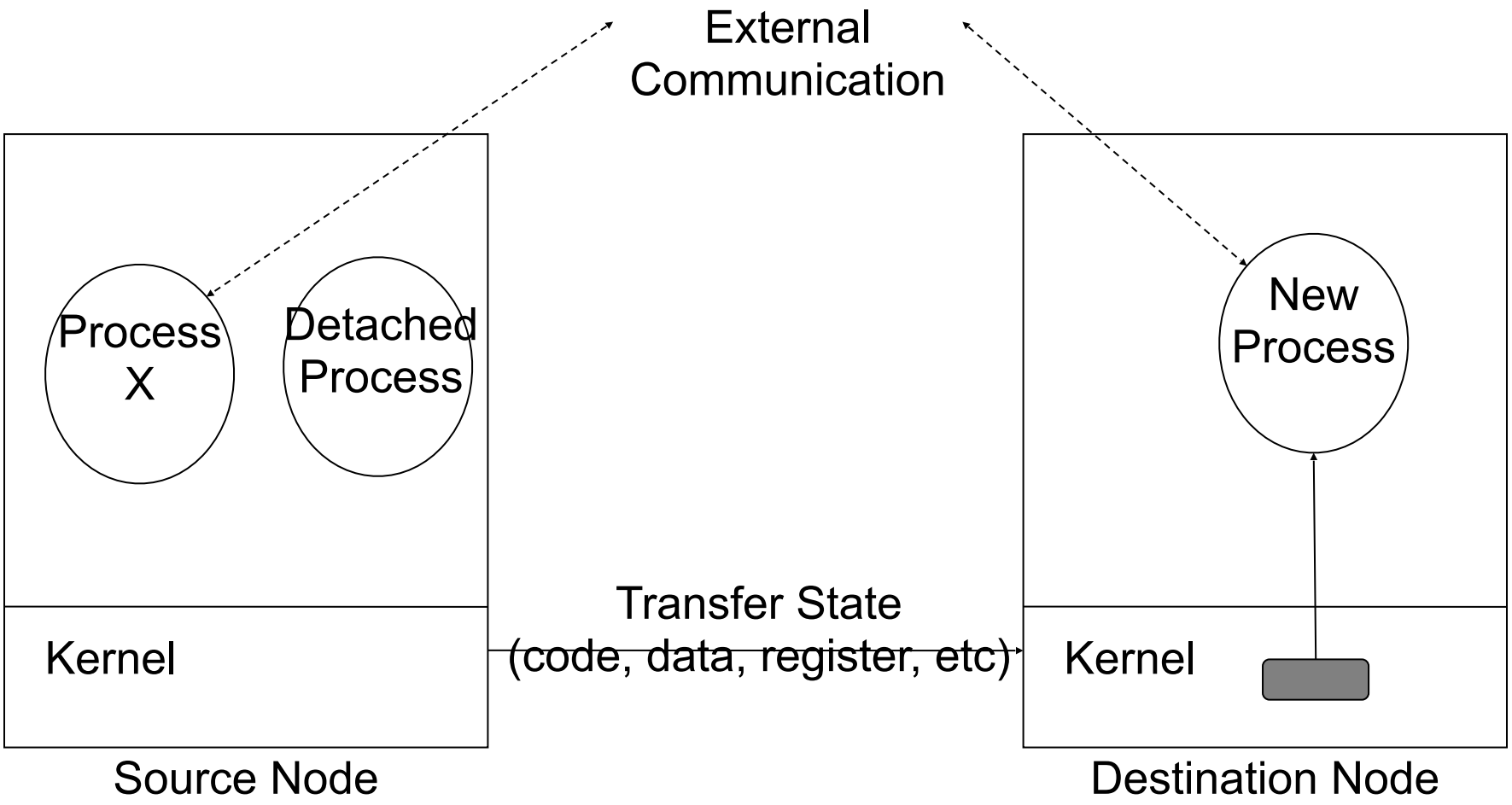
4-The process state is extracted which includes its memory contents, processor state (register contents), communication state (e.g., opened files and message channels) and relevant kernel context.



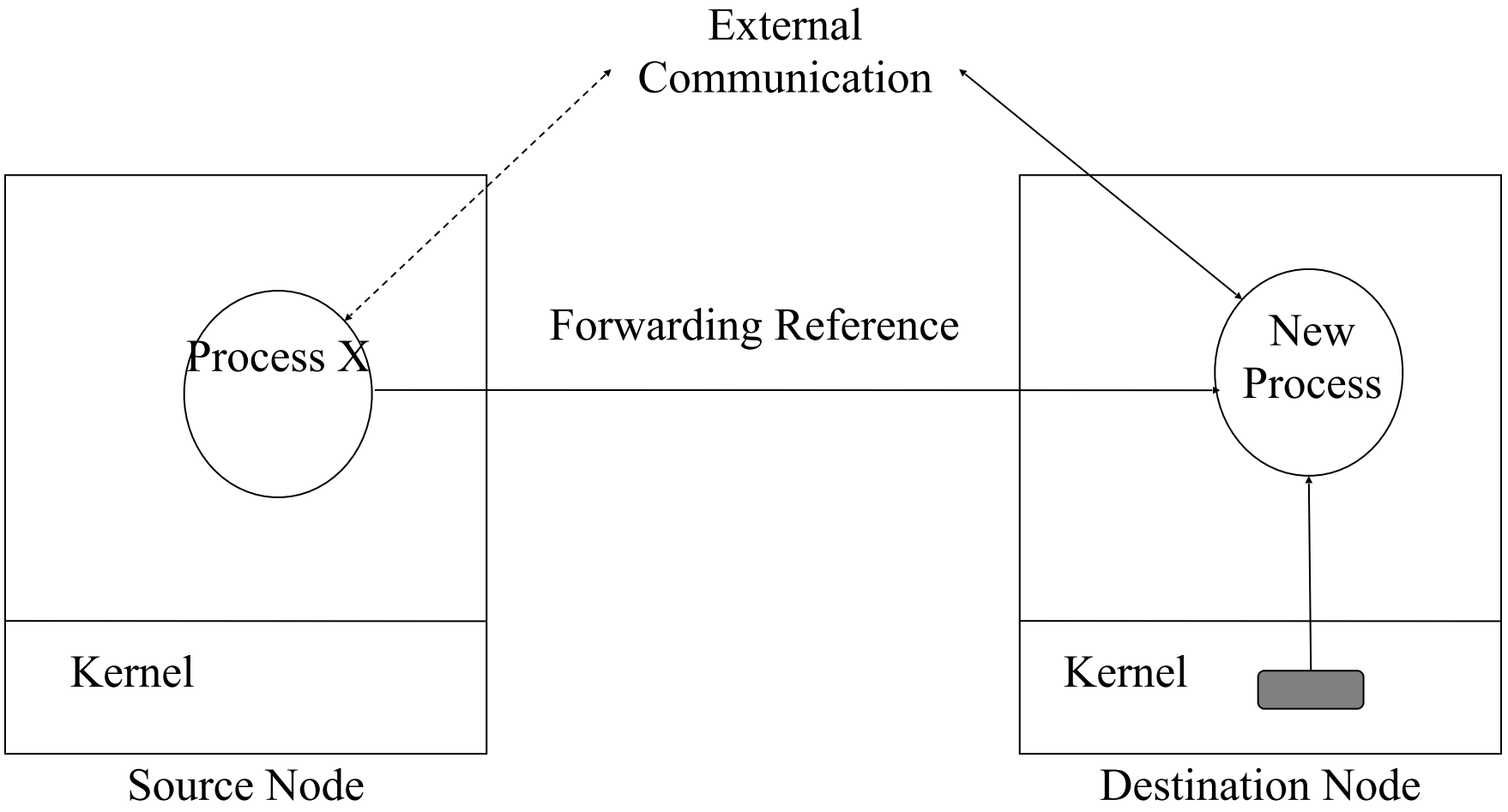
5-A destination process instance is created into which the transferred state will be imported.



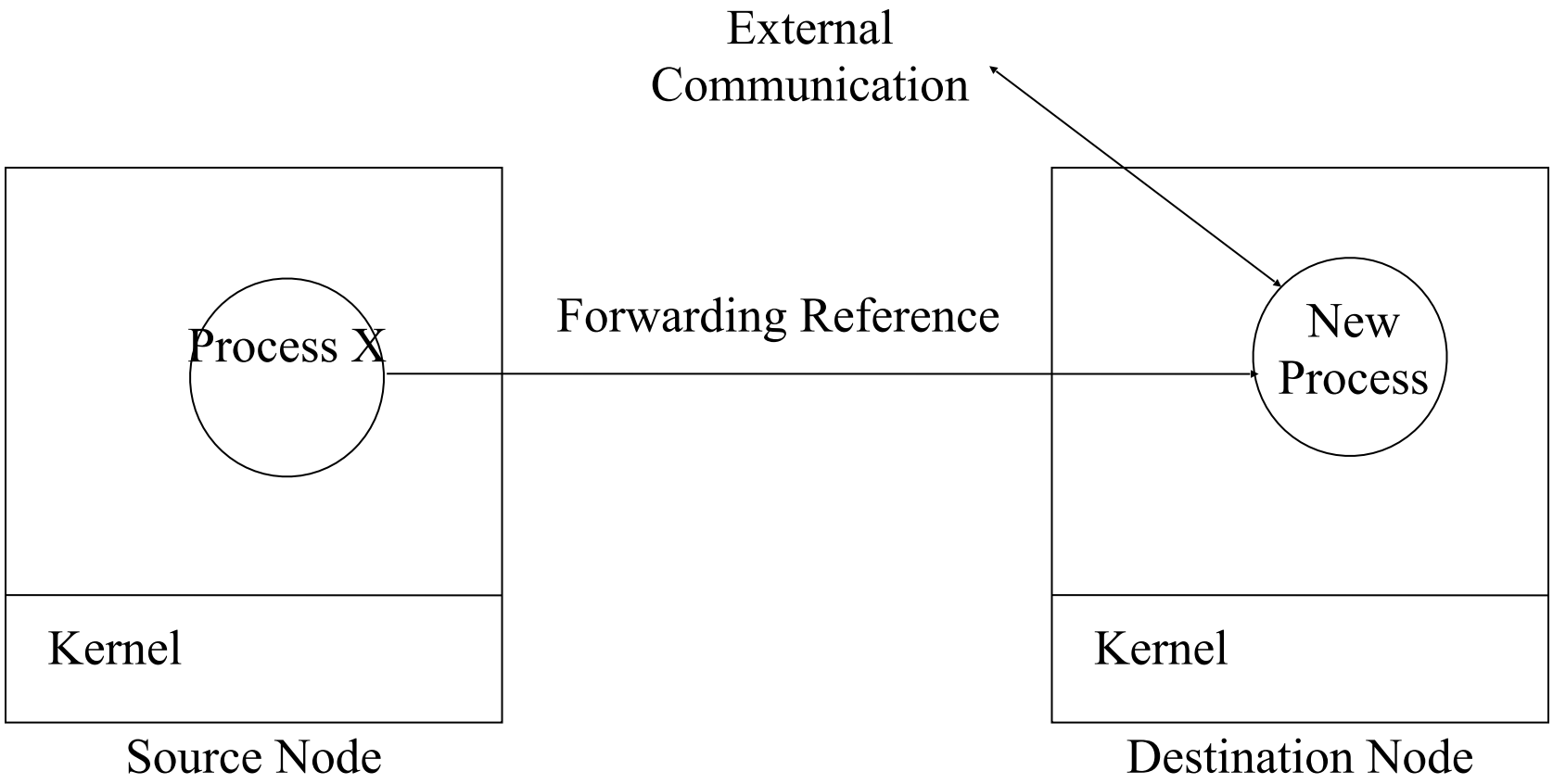
6-State is transferred and imported into a new instance on the remote node. All of the states need not be transferred at once.



7-Some means of forwarding references



8-The new instance is resumed after transferring all the states.
Old process on the source node may be deleted next



Advantages of Process Migration

1. Dynamic load distribution
2. Fault resilience
3. Improved system administration
4. Data access locality
5. Resource sharing
6. Mobile computing

Applications of Process Migration

1. Parallelizable applications: parallel virtual machine, load balancing
2. Long-running applications: helps in partial node failure
3. Generic multiuser workloads: multi-user computer
4. A pre-emptable application: resource sharing, fault resilience
5. Migration-aware applications
6. Network and mobile computing applications

Alternatives to Process Migration

1. Remote execution: invocation of code or transferring the code in the remote node
2. Cloning: child process inherits states from parent process, remote fork mechanism
3. Mobile agents: safe and secure
4. Object migration at the middleware level: helps in distributed systems and heterogeneity

Physical Mobility

- Networked communication while mobile
- Physical mobility permits continuous access to the services and resources of land-based networks
- Networking and Physical Mobility has given rise to following applications:
  - Collaborative software to support wireless meetings
  - Electronic bulletin boards to adapt contents to people
  - Smart home system equipped with IoT devices
  - Navigation software to guide users in unfamiliar places

Requirements for Physical Mobility

- Wireless Communication
- Mobility
  - Address migration
  - Location-dependant information
  - Migrating locality
- Portability
- Small user interface

Mobile IP

- Mobile Internet Protocol addresses the issue of mobility
- Mobile IP enables nodes to move from one IP subnet to another
- Goals of Mobile IP
  - Continue to work with the existing TCP/IP protocol suite.
  - Provide internet-wide mobility, allowing a host the same IP address, called “Home address”.
  - Optimize local area mobility without sacrificing performance or functionality of the general case.
  - Checks if mobility is handled at the network layer.
  - Ensure minimizing power consumption, since mobile nodes are likely to be battery powered.

Mobility Support

- **Mobile Node**: A host or router that changes its point of attachment from one network to other
- **Home Agent**:This is a router on a mobile node's home network, which 'tunnels' or re-directs datagrams for delivery to the mobile node, when it is away from home and maintains the current location information for the mobile node
  - It maintains a **mobility binding table** where each entry is identified by the 3-tuple <permanent home address, temporary care-of address, association lifetime>

Home Address	Care-of Address	Lifetime (in sec)
131.193.171.4	128.172.23.78	200
131.193.171.2	119.123.56.78	150

Mobility Support

- **Foreign Agent:** The foreign agent de-tunnels and delivers datagrams to the mobile node that were tunneled by the mobile node's home agent.
- The foreign agent maintains a **visitor list** which contains information about the mobile nodes currently visiting that network. Each entry in the visitor list is identified by the 4-tuple: < permanent home address, home agent address, media address of the mobile node, association lifetime>.

Home Address	Home Agent Address	Media Address	Lifetime (in s)
131.193.44.14	131.193.44.7	00-60-08-95-66-E1	150
131.193.33.19	131.193.33.1	00-60-08-68-A2-56	200

Mobile IP Protocol

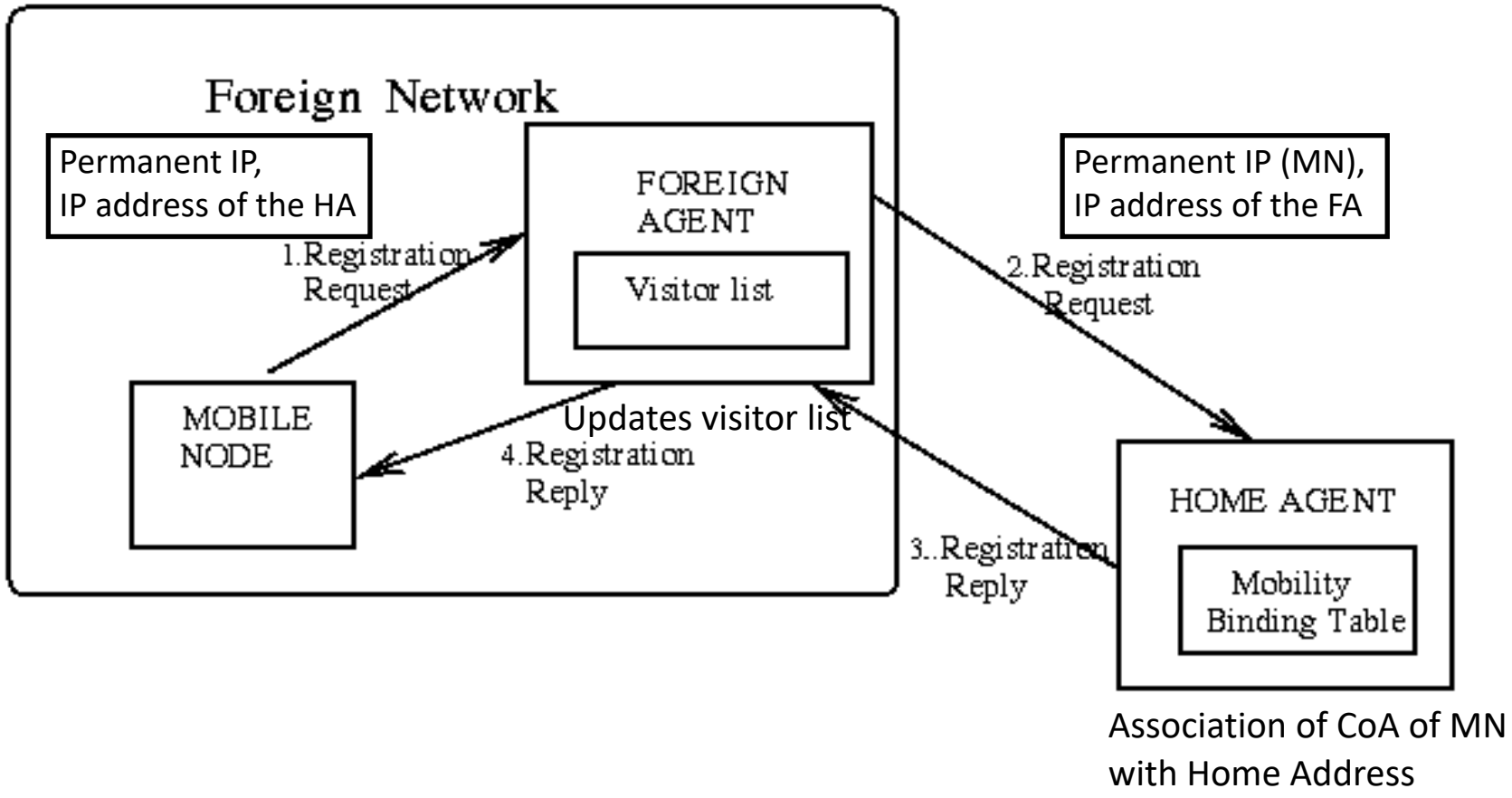
- Mobile IP Protocol has 4 distinct stages:
  - Agent discovery
  - Registration
  - In Service
  - Deregistration

Mobile IP

- Agent Discovery
  - Mobile Agents advertises their presence by broadcasting agent advertisement message, listing one or more care-of address and a flag
  - Upon receiving broadcast message, mobile node determines whether it is in home network or foreign network
  - If mobile node does not wish to wait for advertisement, it sends out Agent Solicitation message that will be responded by mobile agent

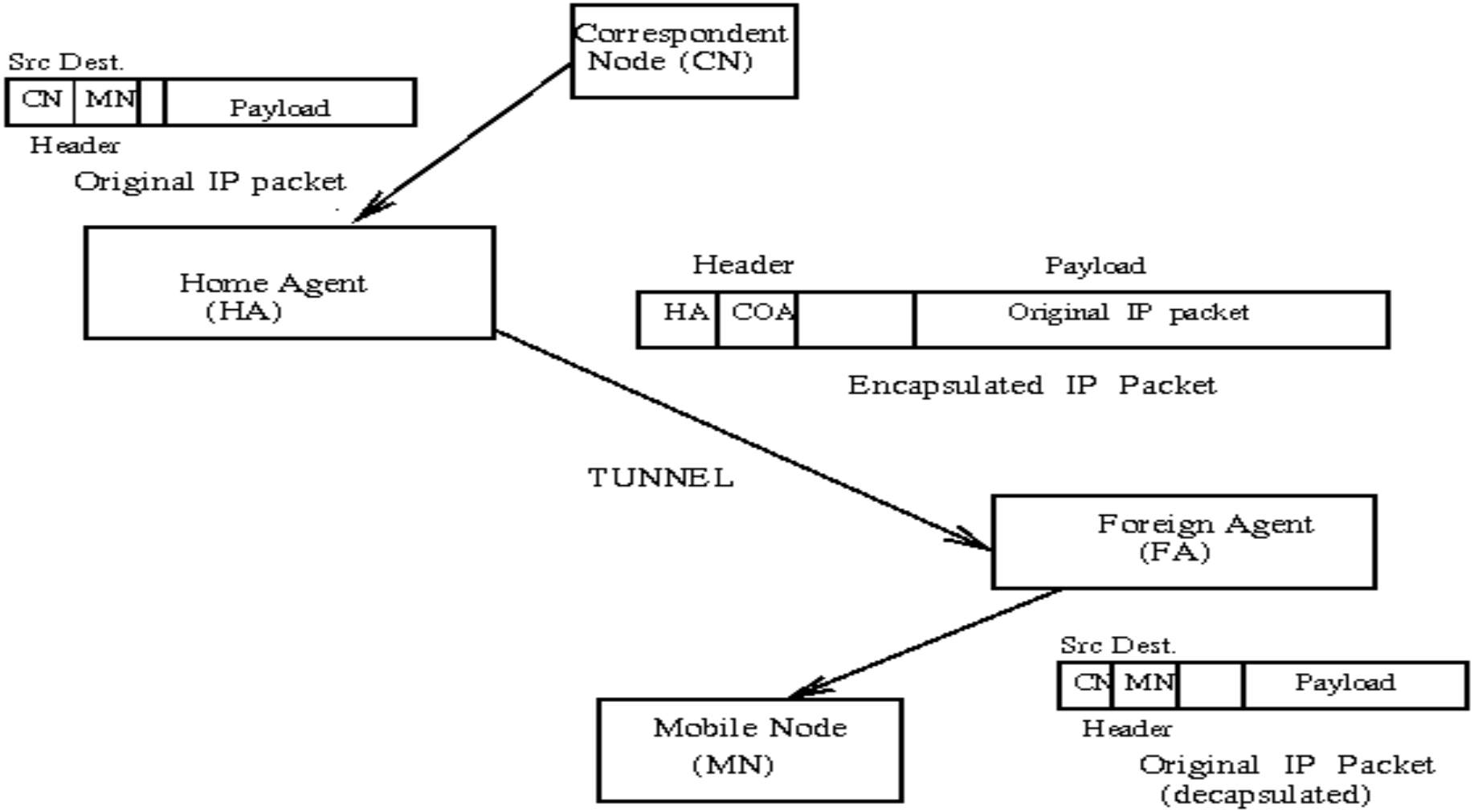
Mobile IP

- Registration



Mobile IP

- In Service: IP within IP encapsulation or tunnelling



Mobile IP

- Deregistration
  - To deregister with its home agent, mobile node sends a registration request with lifetime zero
  - No need of deregistering with the foreign agent

Mobile IP

- Authentication: Home agent has to be certain that registration was originated by mobile node. For this, mobile node and home agent share a security association and create digital signature by Message Digest 5 (MD5)
- To overcome replay attacks, identification field with timestamps or a pseudorandom number (nonces) are used for every new registration.

- “Mobile Computing: Theory and Practice” by Kumkum Garg, Pearson Ed.