Message Passing Model

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Based on original slides by Silberschatz, Galvin and Gagne

Overview

- Message Passing Model
- Addressing
- Synchronization
- Example of IPC systems

Objectives

- To introduce an alternative solution (to shared memory) for process cooperation
- To show pros and cons of message passing vs. shared memory
- To show some examples of message-based communication systems

Inter-Process Communication (IPC)

- Message system – processes communicate with each other without resorting to shared variables.
- IPC facility provides two operations:
  - **send**(*message*) – fixed or variable message size
  - **receive**(*message*)
- If *P* and *Q* wish to communicate, they need to:
  - establish a *communication link* between them
  - exchange messages via send/receive
- The communication link is provided by the OS

Implementation Issues

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Physical implementation

- Single-processor system
  - Shared memory
- Multi-processor systems
  - Hardware bus
- Distributed systems
  - Networking System + Communication networks

Implementation Issues

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Logical properties

- Can a link be associated with more than two processes?
- How many links can there be between every pair of communicating processes?
- What is the capacity of a link?
- Is the size of a message that the link can accommodate fixed or variable?
- Is a link unidirectional or bi-directional?

Implementation Issues

Other Aspects

- Addressing
- Synchronization
- Buffering

Overview

- Message Passing Model
- **Addressing**
- Synchronization
- Example of IPC systems

Direct Addressing

- Processes must name each other explicitly.
- Symmetric scheme
  - **send** (*D, message*) – send a message to process *D*
  - **receive**(*S, message*) – receive a message from process *S*
- Logical properties
  - A communication link exits between exactly two process
  - Links are established automatically
  - Links are usually FIFO

Direct Addressing

- Asymmetric scheme
  - **send** (*D, message*) – send a message to process *D*
  - **receive**(*proc*, message) - receive a message from any process *proc*

Indirect Addressing

- Messages are sent/received through mailboxes
  - shared data structures where messages are queued temporarily. Sometimes referred to as **ports**
- Processes can communicate only if they share a mailbox
  - Each mailbox has a unique id
  - Processes can communicate only if they share a mailbox
- Primitives are defined as:

  send(*mb, message*) – send a message to mailbox A

  receive(*mb, message*) – receive a message from mailbox *mb*

Indirect Communication

- Operations
  - create a new mailbox
  - send and receive messages through mailbox
  - destroy a mailbox
- Properties of communication link
  - Link established only if processes share a common mailbox
  - A link may be associated with many processes
  - Each pair of processes may share several communication links
  - Link may be unidirectional or bi-directional
- Relationships
  - One-to-one (private communication)
  - Many–to-one (client-server communication)
  - Many-to-many (multicast communication)

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Synchronization

- **Send** operations may be
  - **Synchronous**
  - **Asynchronous**
- **Receive** operations may be
  - **Blocking**
  - **Non-blocking**

Synchronization

- Blocking send, blocking receive
  - Rendez-vous between sender and receiver
- Non-blocking send, blocking receive
  - Most useful combination (used by servers)
  - Variations: receive with timeout, select, proactive test
- Non-blocking send, Non-blocking receive
  - Neither party is required to wait

Buffering

- Queue of messages attached to the link; implemented in one of three ways.

1. Zero capacity – 0 messages
   Sender must wait for receiver (rendezvous di fatto).
2. Bounded capacity – finite length of *n* messages
   Sender must wait if link full.
3. Unbounded capacity – infinite length
   Sender never waits.

Producer-Consumer: Solution (1)

```
Mailbox mb;
```

```
Process Producer {
  while (TRUE) {
    // message in nextProduced
    send(mb, nextProduced);
  }
}
```

```
Process Consumer {
     while (TRUE) {
        receive(mb, msg);
        // consume message
      }
}
```

Producer-Consumer: Solution (2)

```
Mailbox mb1, mb2;
```

```
Process Producer {
  while (TRUE) {
    // message in nextProduced
    receive(mb2, ack);
    send(mb1, nextProduced);
  }
}
```

```
Process Consumer {
     while (TRUE) {
        send(mb2, READY);
        receive(mb1, msg);
        // consume message
      }
}
```

Overview

- Message Passing Model
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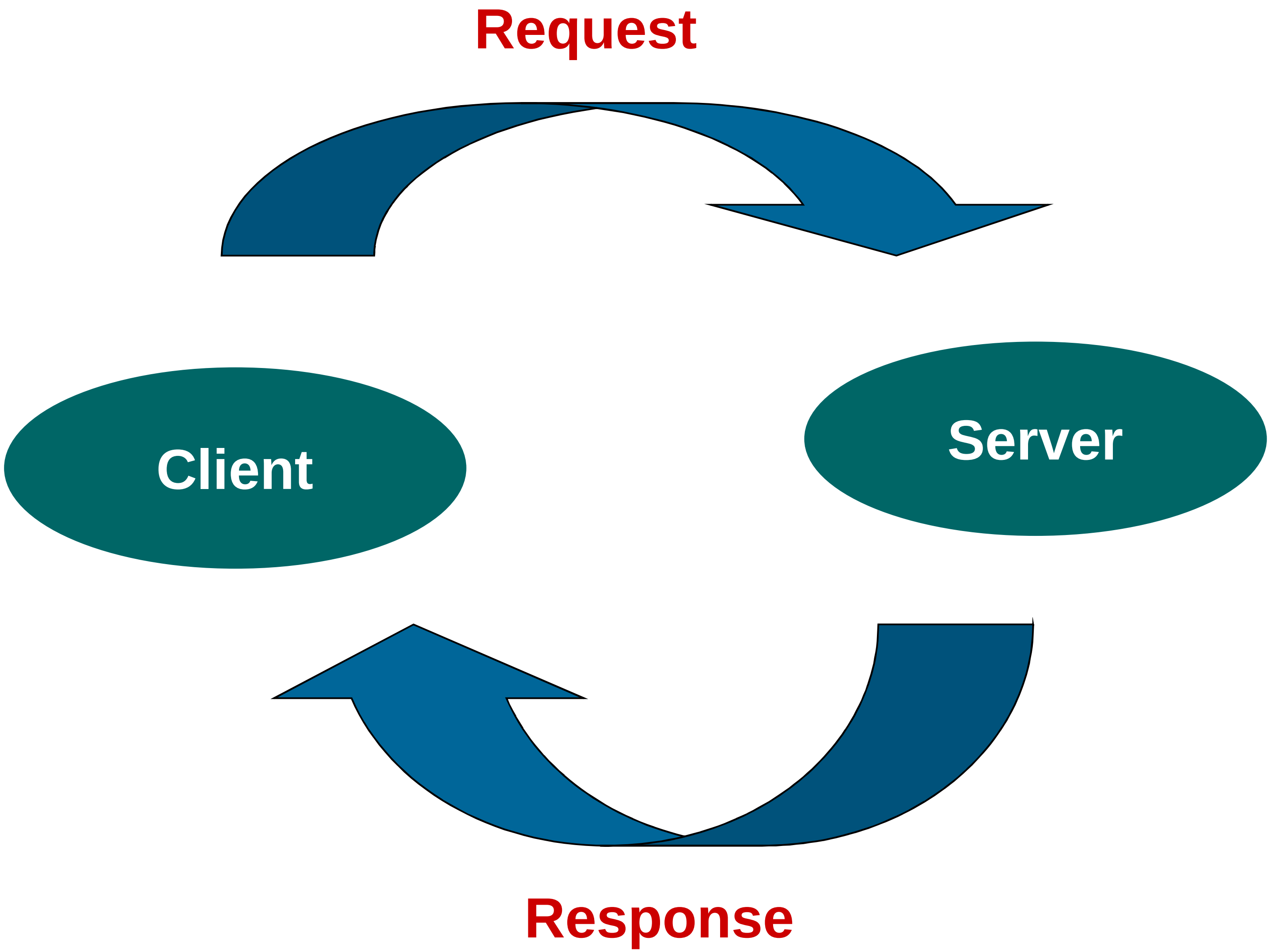
- Synchronization
- Client-Server Model

Client-Server Communication



Questions?

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