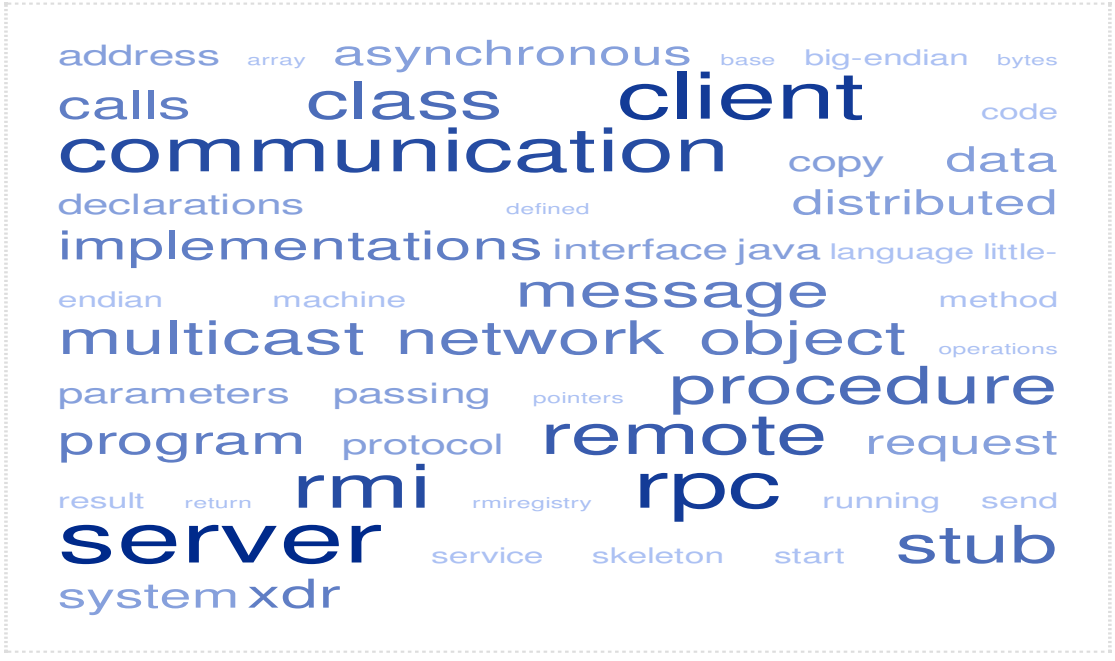
Communication



Overview

- Communication types and role of Middleware
- Remote Procedure Call (RPC)
- Message Oriented Communication
- Multicasting

Communication Types

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- Synchronous communication. The sender is blocked until its request is known to be accepted. This can happen at three places.
  - The sender may be blocked until the middleware notifies that it will take over the transmission of the message.
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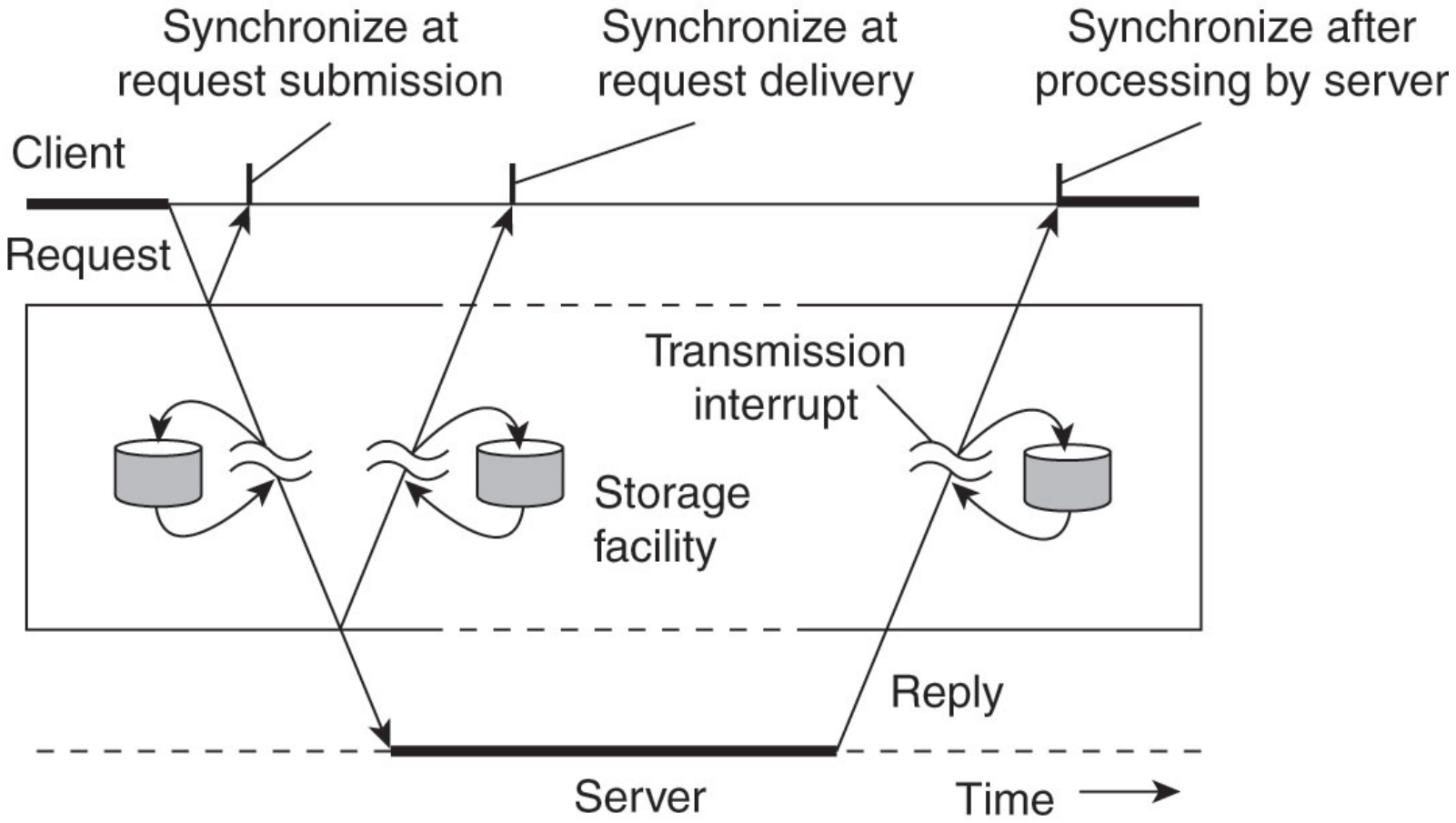
  - The sender waits until its request has been fully processed, that is, up to the time that the recipient returns a response.
- Asynchronous communication. The sender continues immediately after it has submitted its message for transmission. This means that the message is (temporarily) stored stored immediately by the middleware upon transmission.

Role of Middleware



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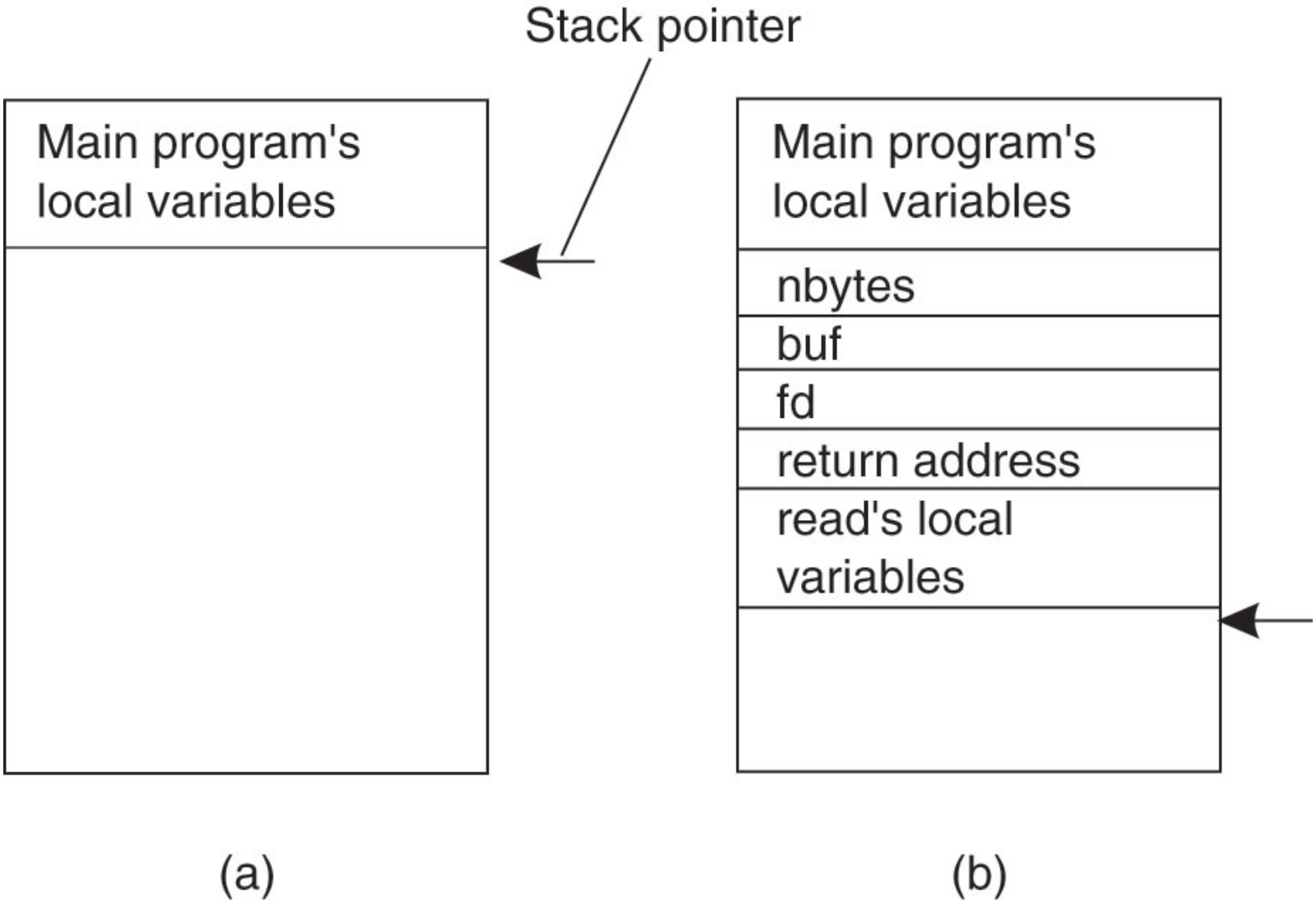
- A widely used technique that underlies many distributed systems.

Conventional Procedure Call




```
count = read(fd, buf nbytes); //in main
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- **In-class Exercise**. How is call-by-copy/restore different from call-by-reference?

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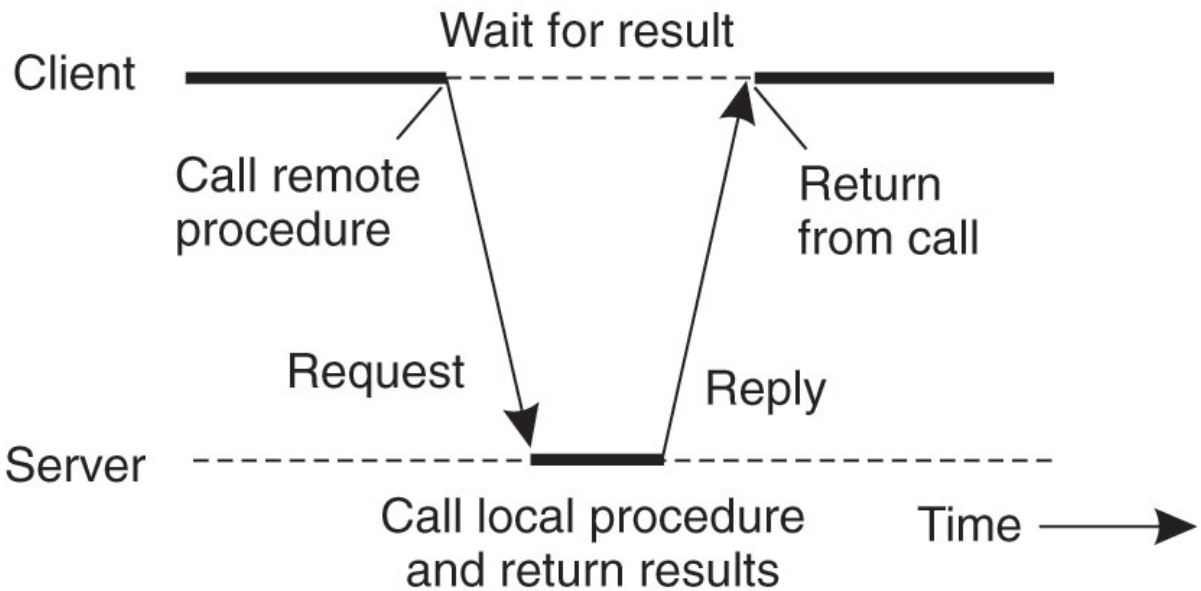

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- The server stub unpacks the parameters and calls the server.

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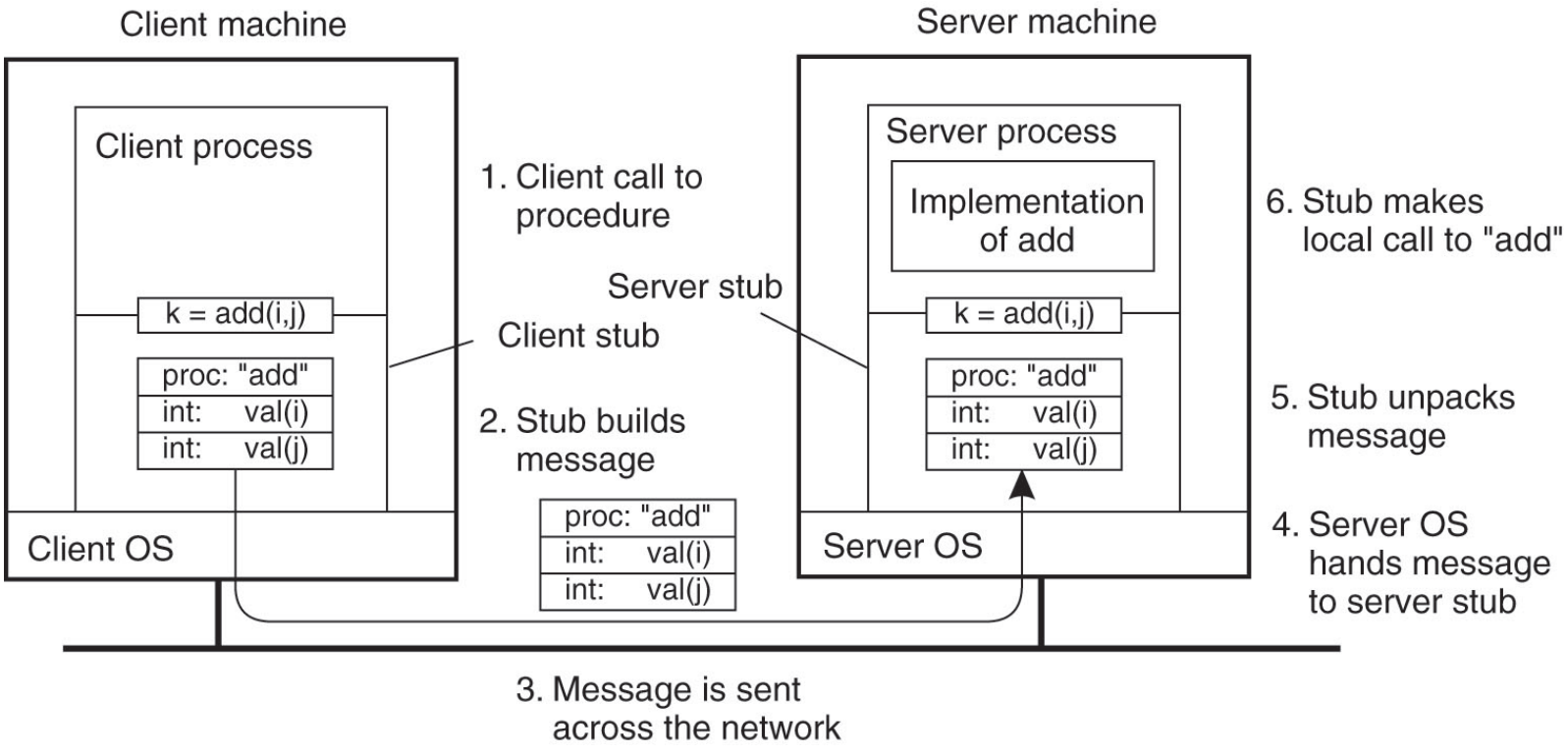
RPC: Passing Parameters



Representation: Little-Endian vs Big-Endian (1)

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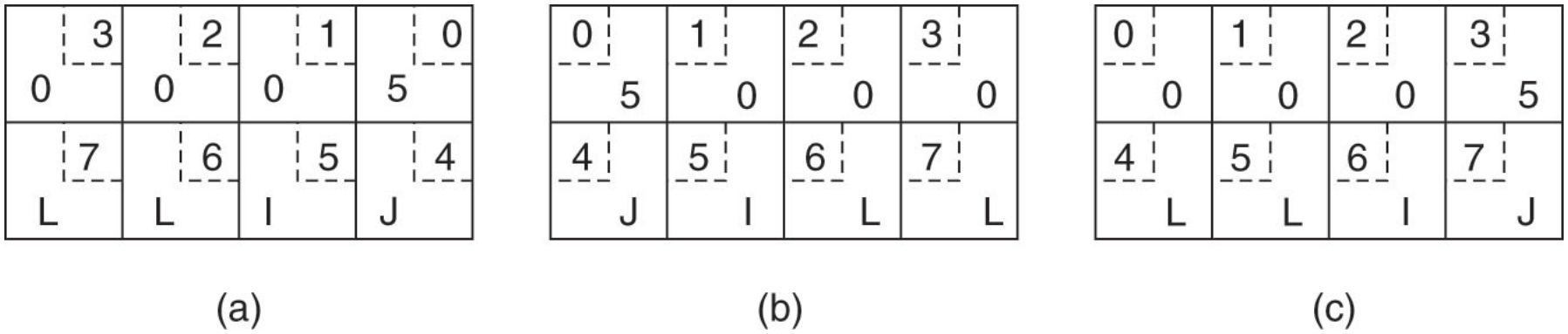
- Bi-endian machine: Choose either setting either via software or hardware. E.g. ARM processors, SPARC, POWER PC.

Representation: Little-Endian vs Big-Endian (2)



(a) (b) (c)

a. Little endian (data before sending)

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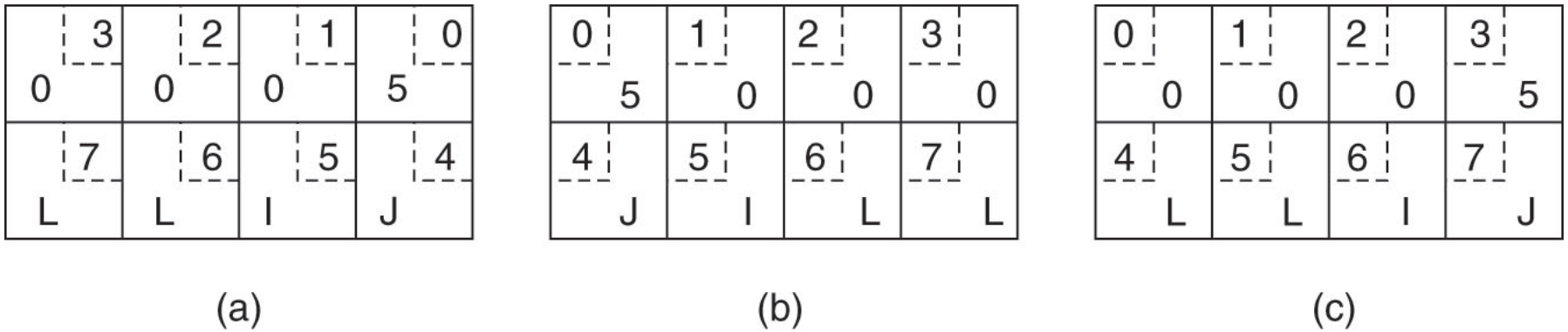

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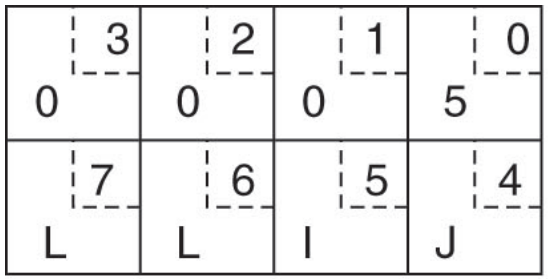

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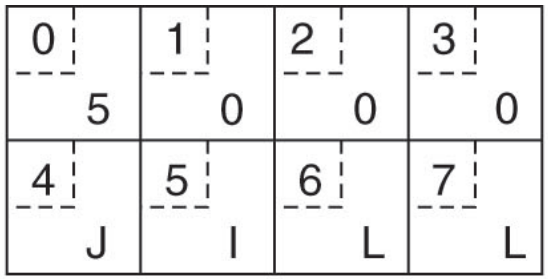

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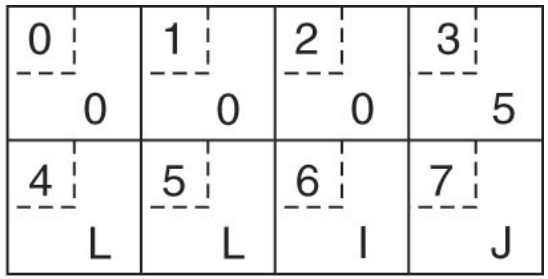

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a. Little endian (data before sending)
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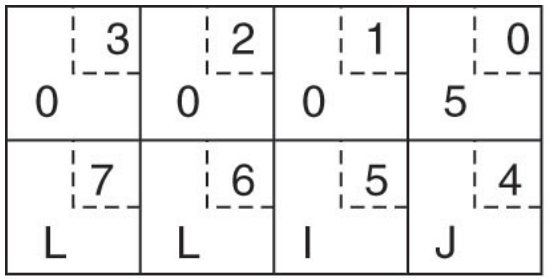

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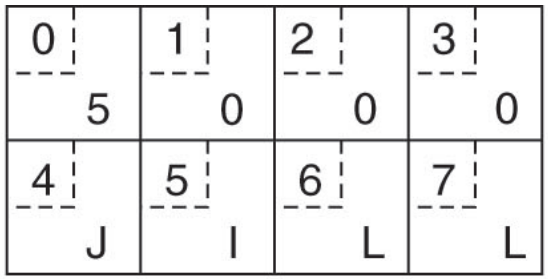

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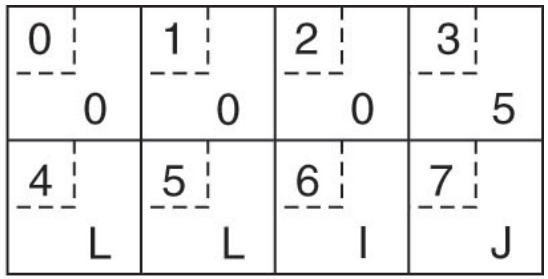

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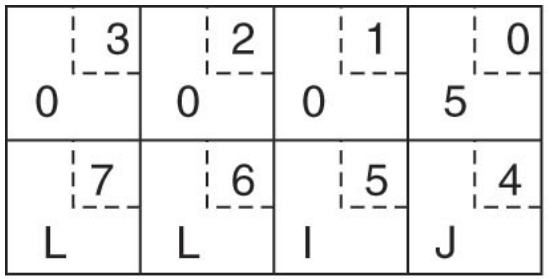

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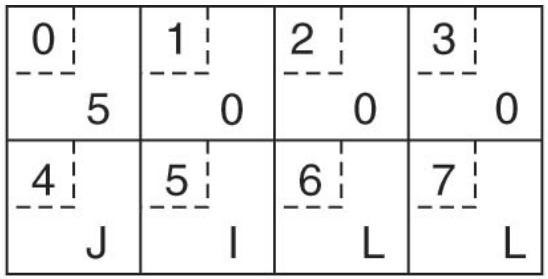

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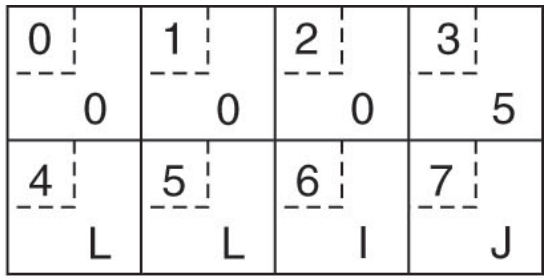

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Does reversing the bytes fix the problem for all data types?

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- **In-class Exercise 2**. Do we need to worry about *endianness* for server and clients written in Java?

Passing Reference Parameters

- *Passing an array or simple structure by reference*: Copy the array into the message. The server stub then calls the server with a pointer to this copy.Changes to the array happen in the message buffer in the server stub that then send back to the client stub, which then copies it back to the client.

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- How about arbitrary data structures with pointers? 

RPC Protocol and Stub Generation

- The RPC protocol would have to define the format of the message, the representation of primitive types and arrays and other data structures. Are integers stored in 2's complement, characters in 16-bit Unicode, floats/doubles in IEEE standard #754 and if everything is big-endian or little-endian?

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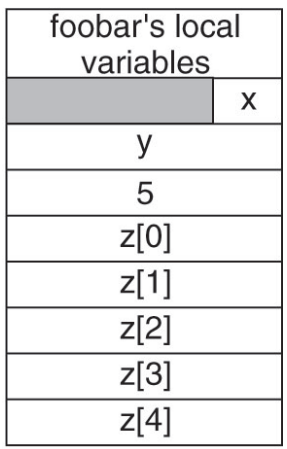

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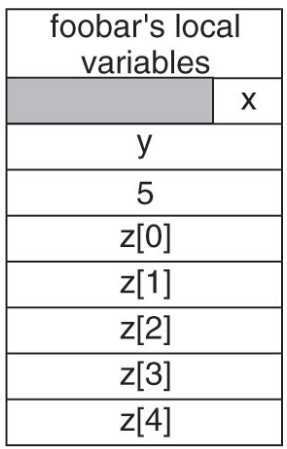

(b)

:

- Interface Definition Language (IDL) is used to define interfaces for RPC. IDL is then compiled into client and server stub along with the appropriate compile/run-time interfaces.

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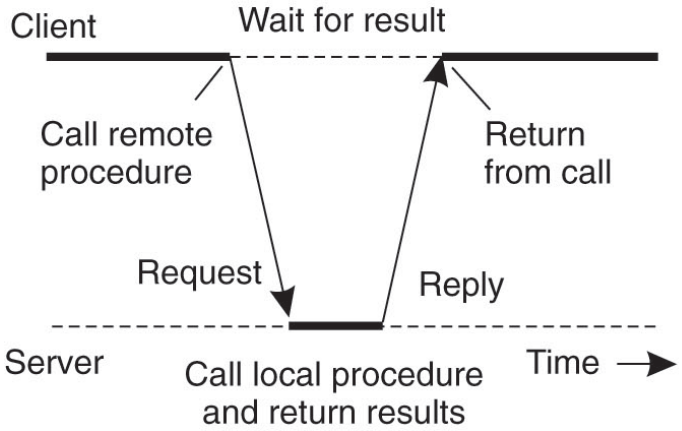
- Deferred asynchronous RPC: The client calls the server with a RPC request and the server immediately acknowledges it. Later the server does a callback to the client with the result.

Asynchronous RPC (2)

- Synchronous (default choice) versus Asynchronous RPC



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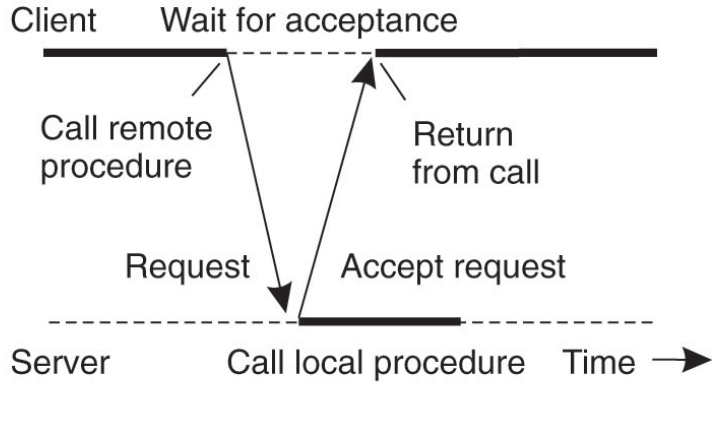

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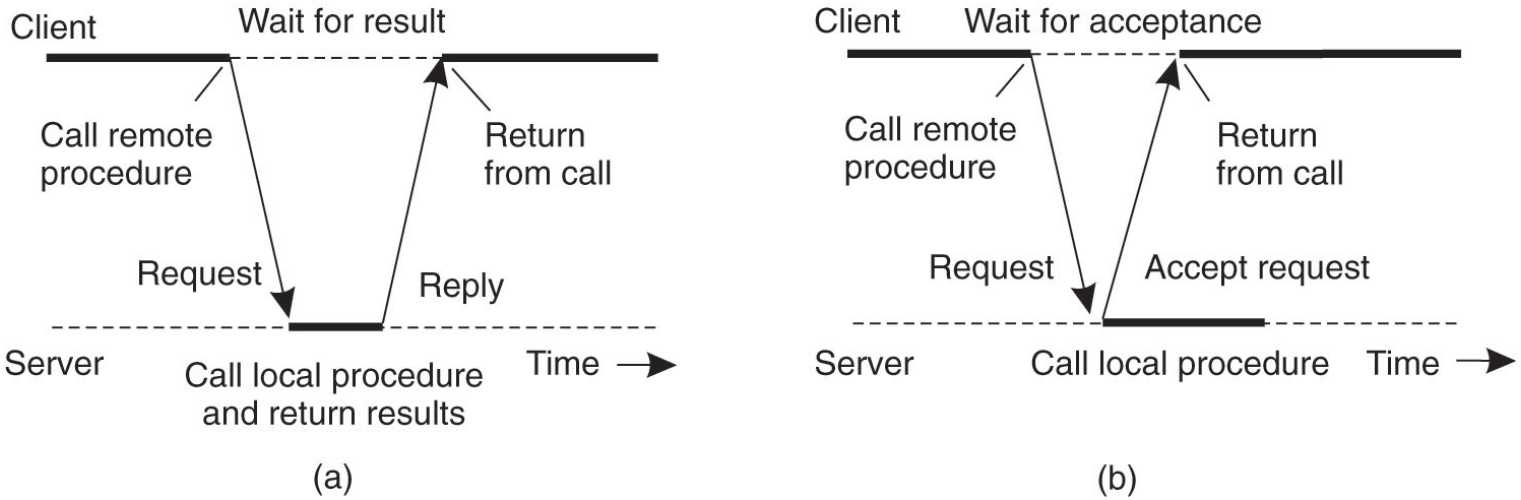

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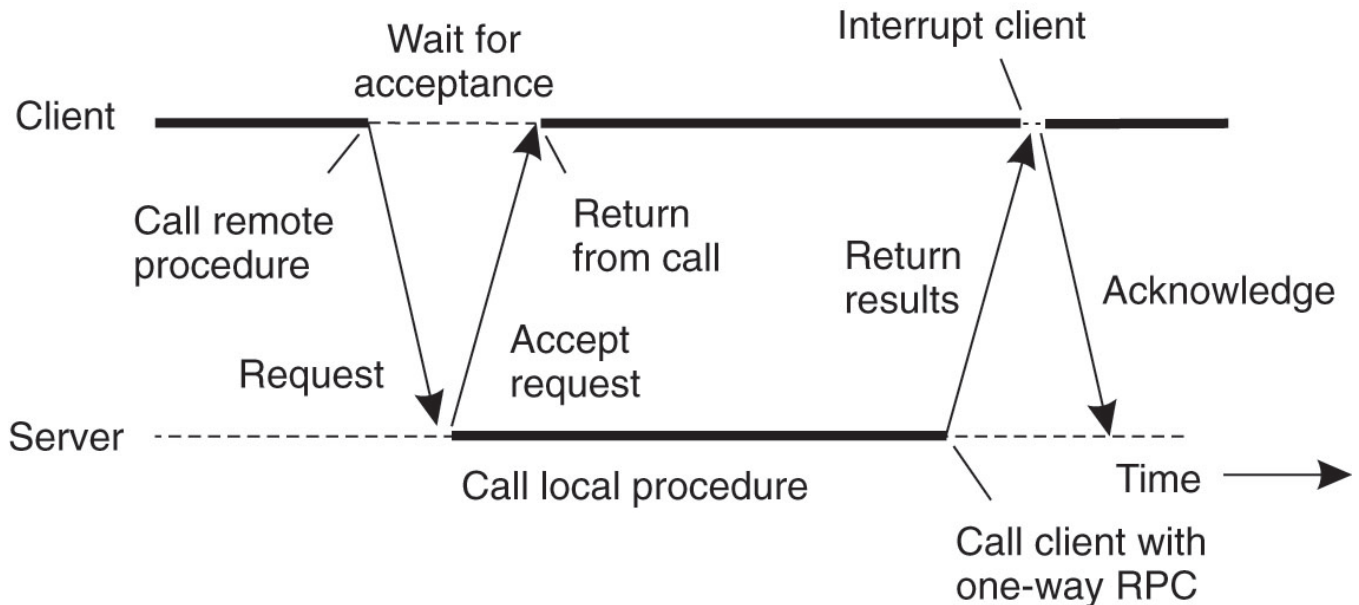

Classic RPC Implementations

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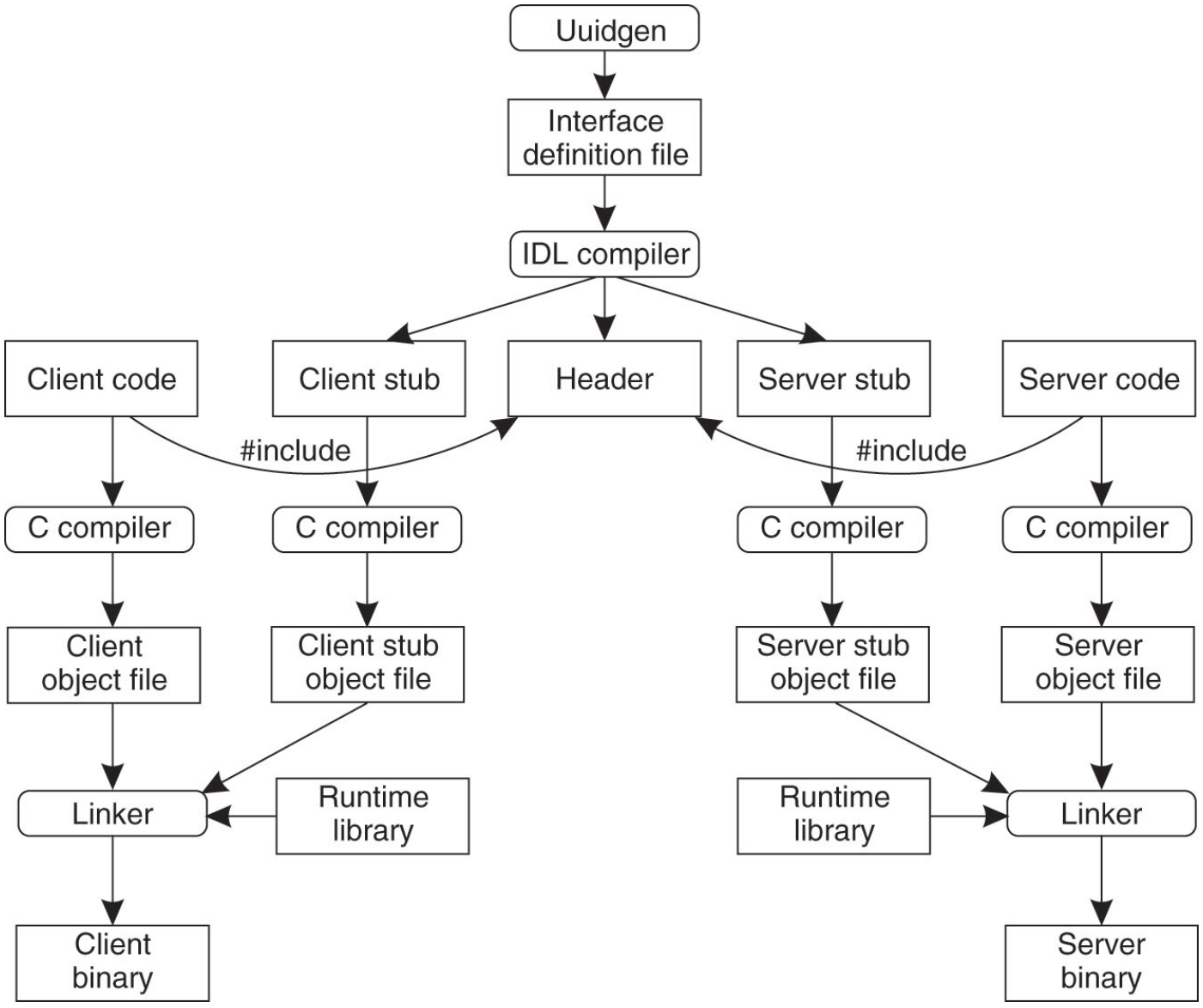
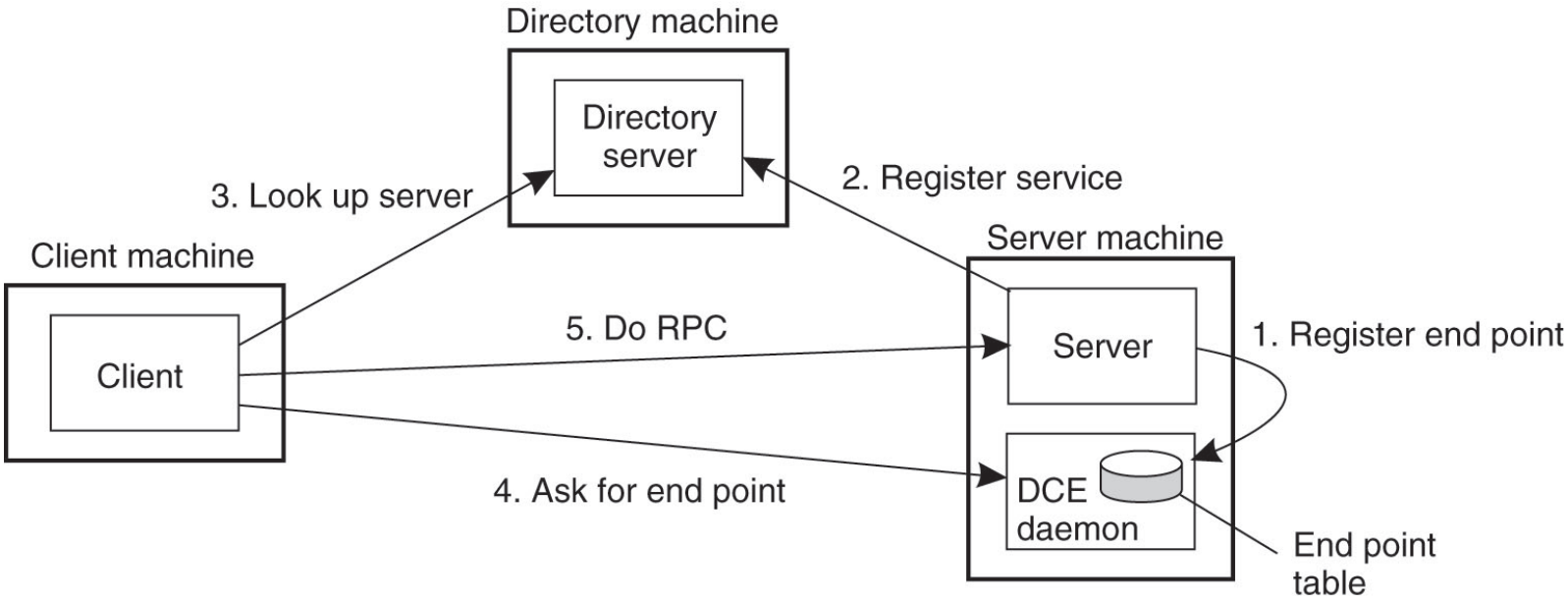
- Open Network Computing Remote Procedure Call (ONC RPC) is a widely deployed remote procedure call system. ONC was originally developed by Sun Microsystems as part of their Network File System project, and is sometimes referred to as Sun ONC or Sun RPC.

Building a RPC Server and Client



Binding a Client to a RPC Server



Note: ONC RPC uses a `portmapper` in place of the DCE daemon. It doesn't use a directory server.

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  - This only works for idempotent operations: something that can be done multiple times without harm.

More RPC Implementations

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- XML-RPC and its successor SOAP: An RPC protocol that uses XML to encode its calls and HTTP as a transport mechanism.

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