



# CLOUD COMPUTING APPLICATIONS

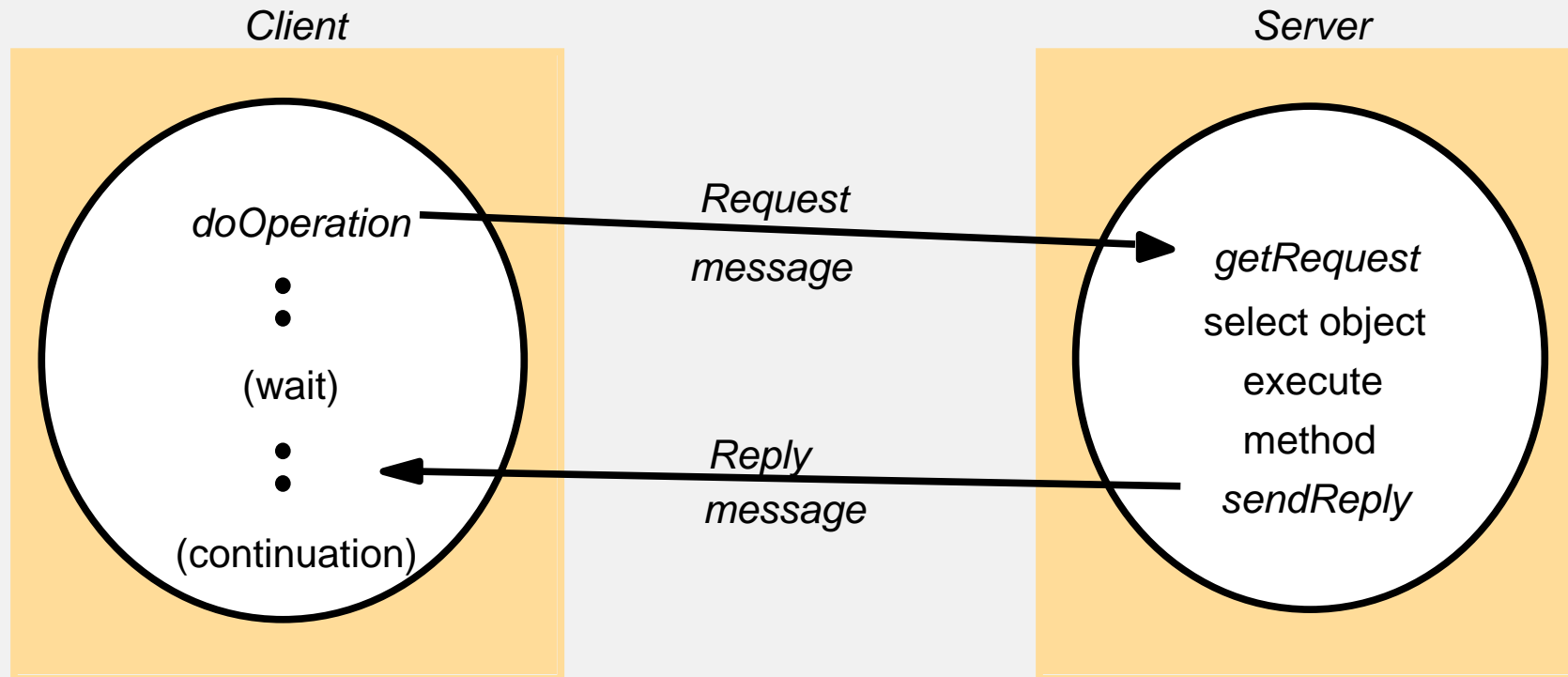
RPC Semantics

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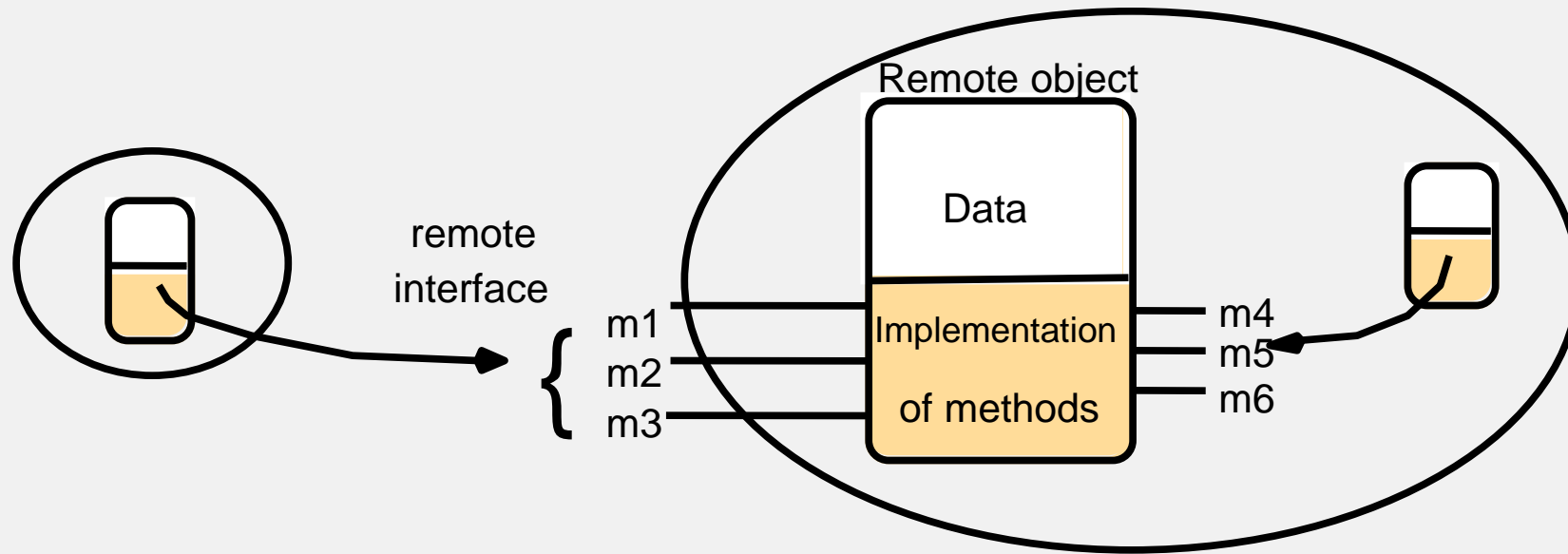
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- Remote Procedure Call Semantics
  - RMI, SOAP

# Request-Reply Communication

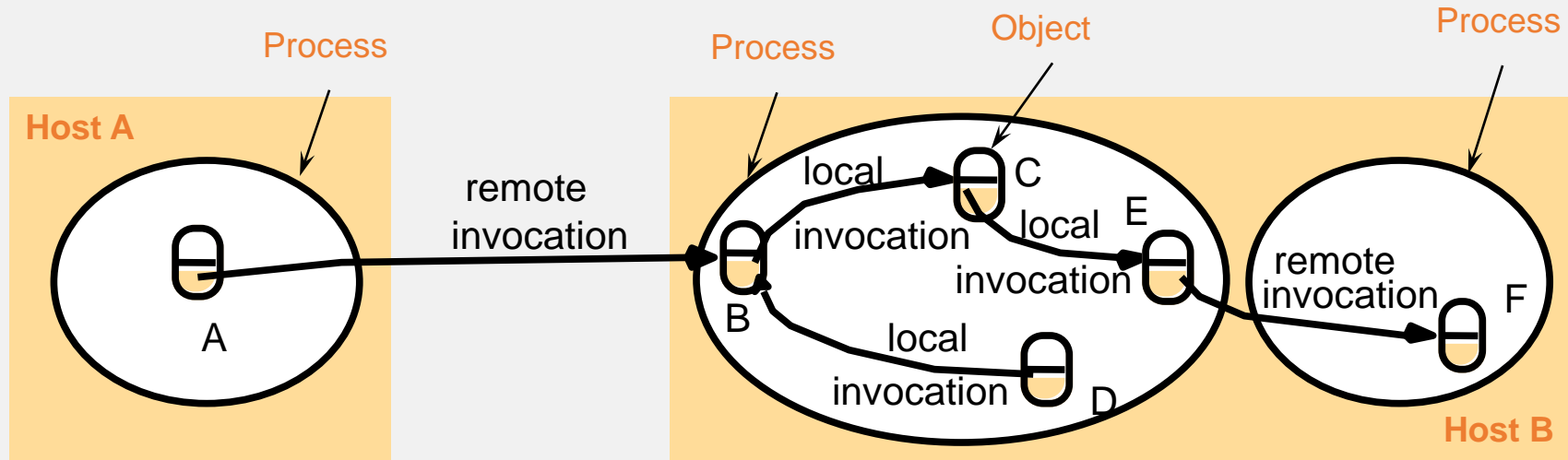


# A Remote Object and Its Remote Interface



Example remote object reference = (IP, port, object number, signature, time)

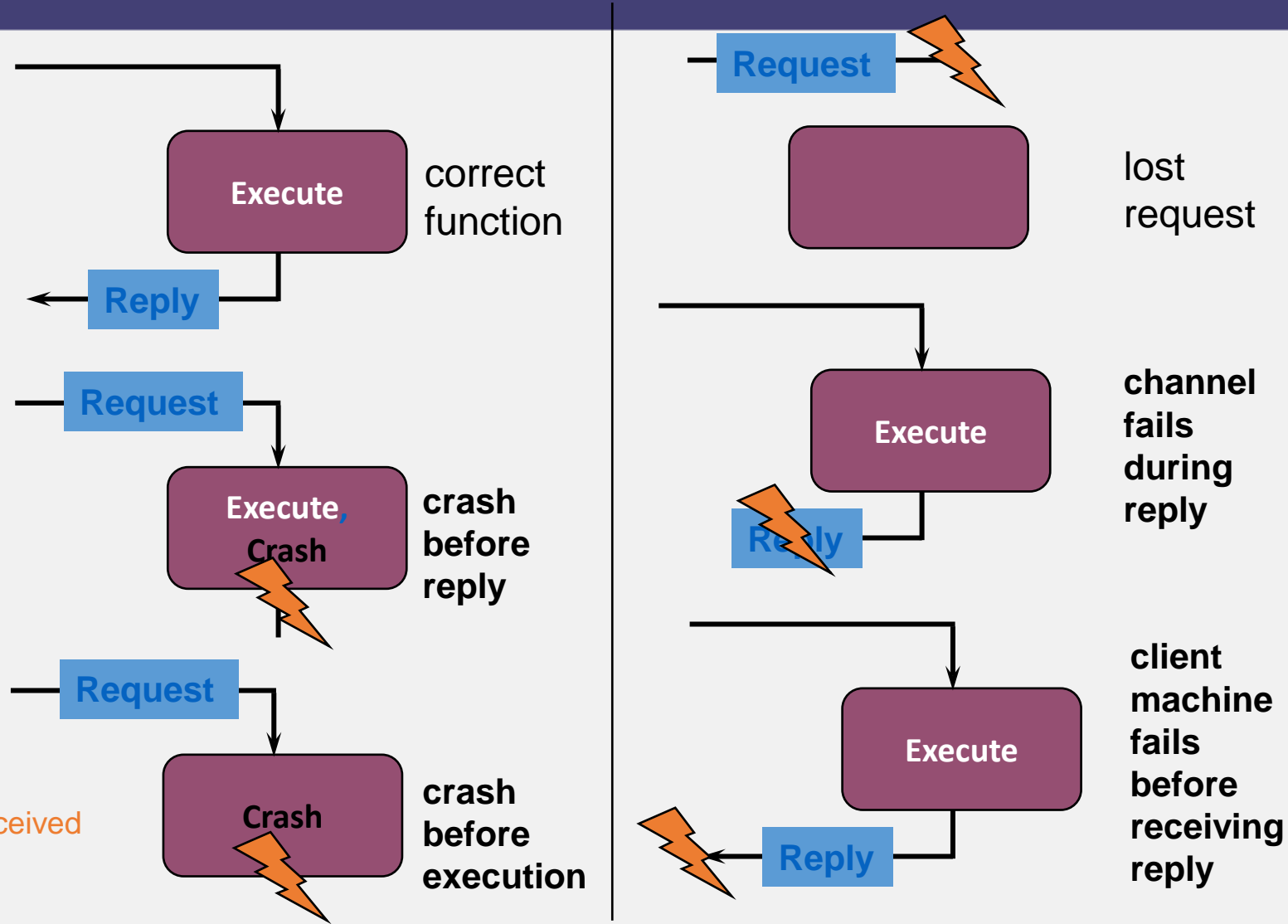
# Remote and Local Method Invocations



**Local invocation** = between objects on same process; has exactly once semantics

**Remote invocation** = between objects on different processes. Ideally, you'd also want exactly once semantics for remote invocations, but it's difficult in distributed systems (why?)

# Failure Modes of RMI RPC



(and if request is received more than once?)

# Invocation Semantics

- Middleware aims at providing **transparency**
  - Sometimes obtaining transparency is expensive and unnecessary
  - Because of faults, obtaining “exactly once” semantics is expensive
- Other invocation semantics are possible
  - **Maybe**: Caller cannot determine whether the remote method has been executed
  - **At-least-once**: Caller either receives a result (in which case the user knows the method was executed at least once) or an exception
  - **At-most-once**: Caller either receives a result (in which case the user knows the method was executed at most once) or an exception
- The right invocation semantic depends on the application
  - For example, at-least-once semantic + **idempotent operations** can provide a semantic that would be equivalent to exactly-once applications

Idempotent = same result if applied repeatedly, w/o side effects

# Invocation Semantics

Retransmit request message	Duplicate filtering	Re-execute procedure or retransmit reply	Invocation semantic	Used in ...
No	N/A	N/A	<i>Maybe</i>	CORBA
Yes	No	Re-execute procedure	<i>At-least-once</i>	Sun-RPC
Yes	Yes	Retransmit old reply	<i>At-most-once</i>	RMI;CORBA

**Retransmit request message:** Whether to retransmit the request message until either a reply is received or the server is assumed to be failed

**Duplicate filtering:** When retransmissions are used, whether to filter out duplicate requests at the server

**Re-execute procedure or retransmit reply:** Whether to keep a history of result messages to enable lost results to be retransmitted without re-executing the operations