



CLOUD COMPUTING APPLICATIONS

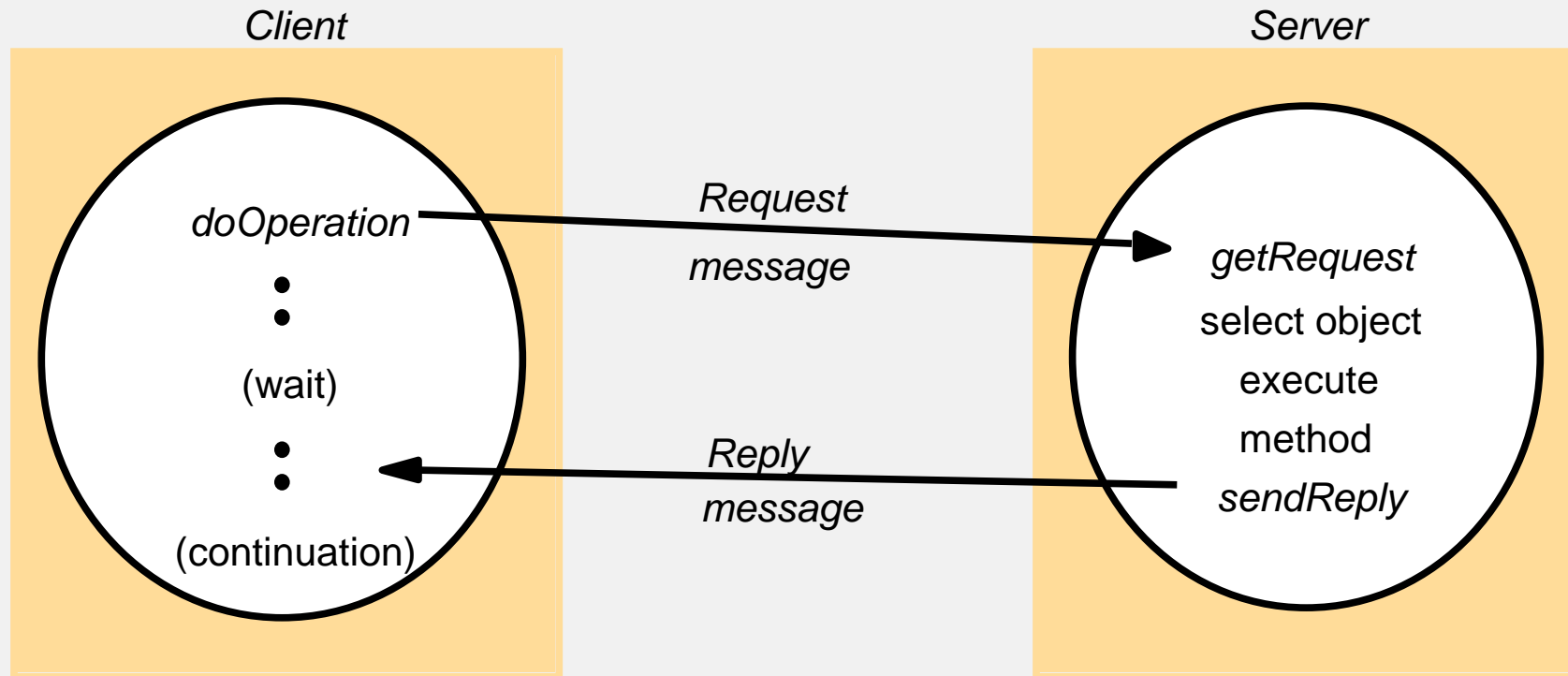
Cloud Services

Prof. Roy Campbell

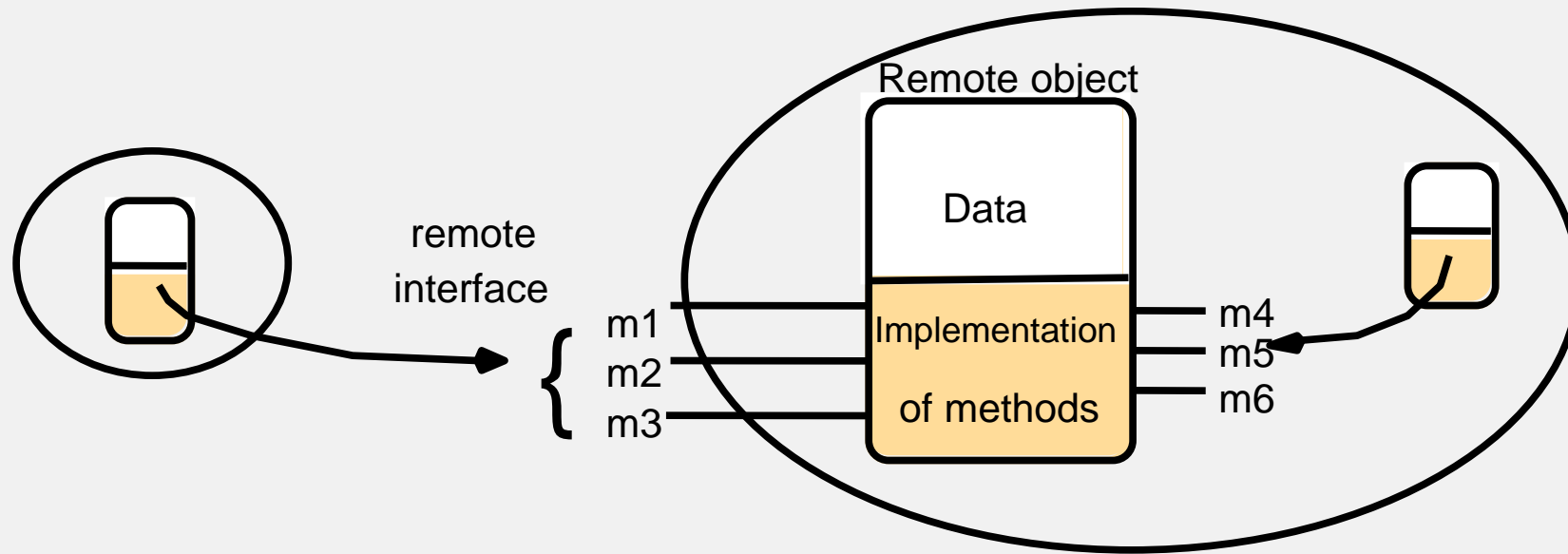
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 - RMI, SOAP

Request-Reply Communication

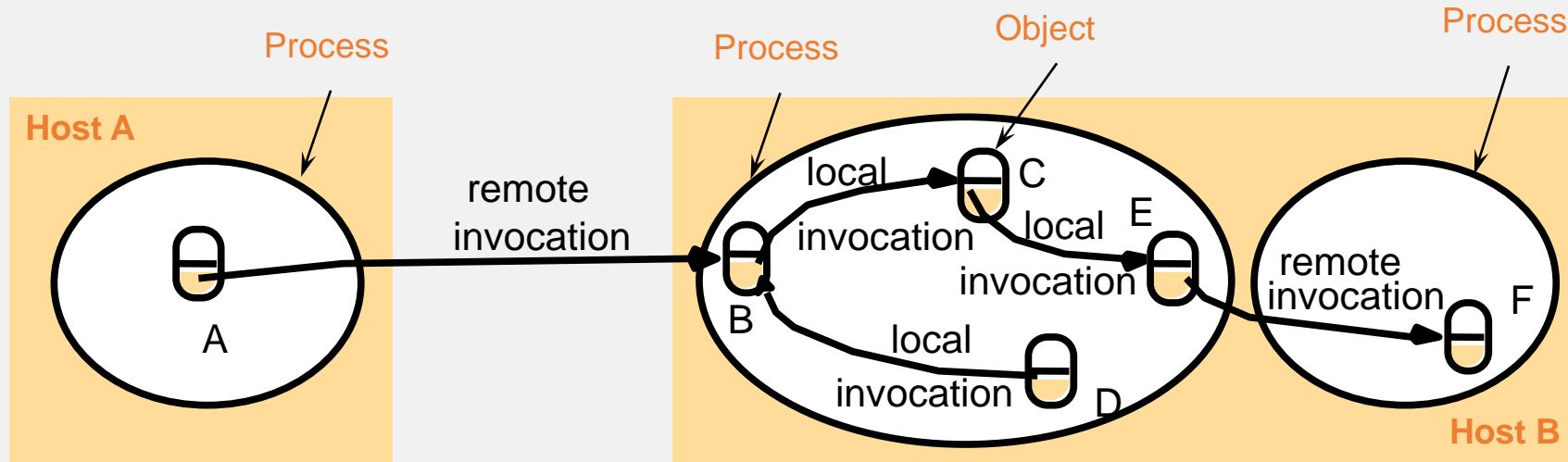


A Remote Object and Its Remote Interface



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

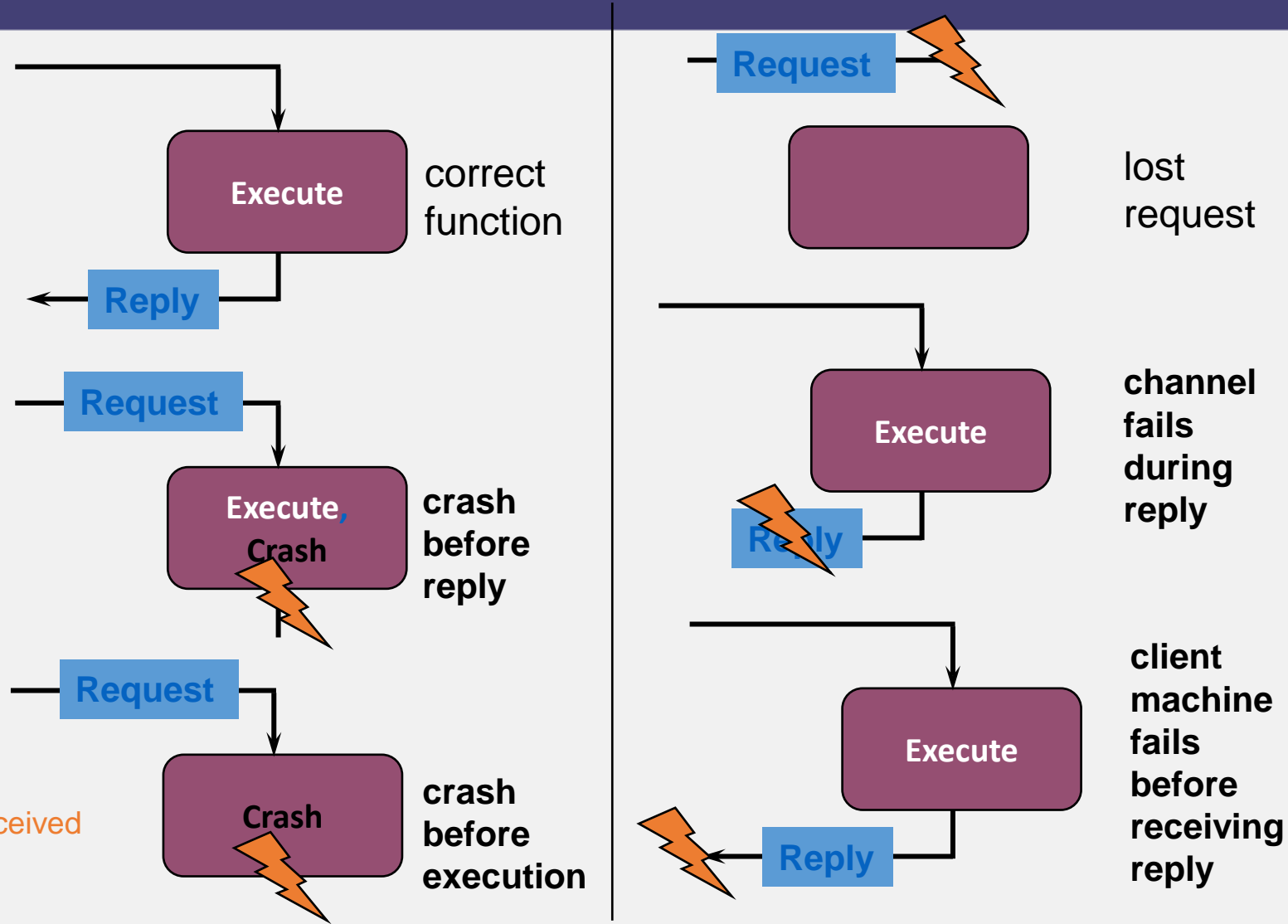
Remote and Local Method Invocations



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