RPC in the modern world

CS 414: Advanced Systems
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RPC Overview

- *Remote procedures can be called as if local.*
  - *... but they execute remotely*
- *The RPC system deals with the network so you don’t have to.*

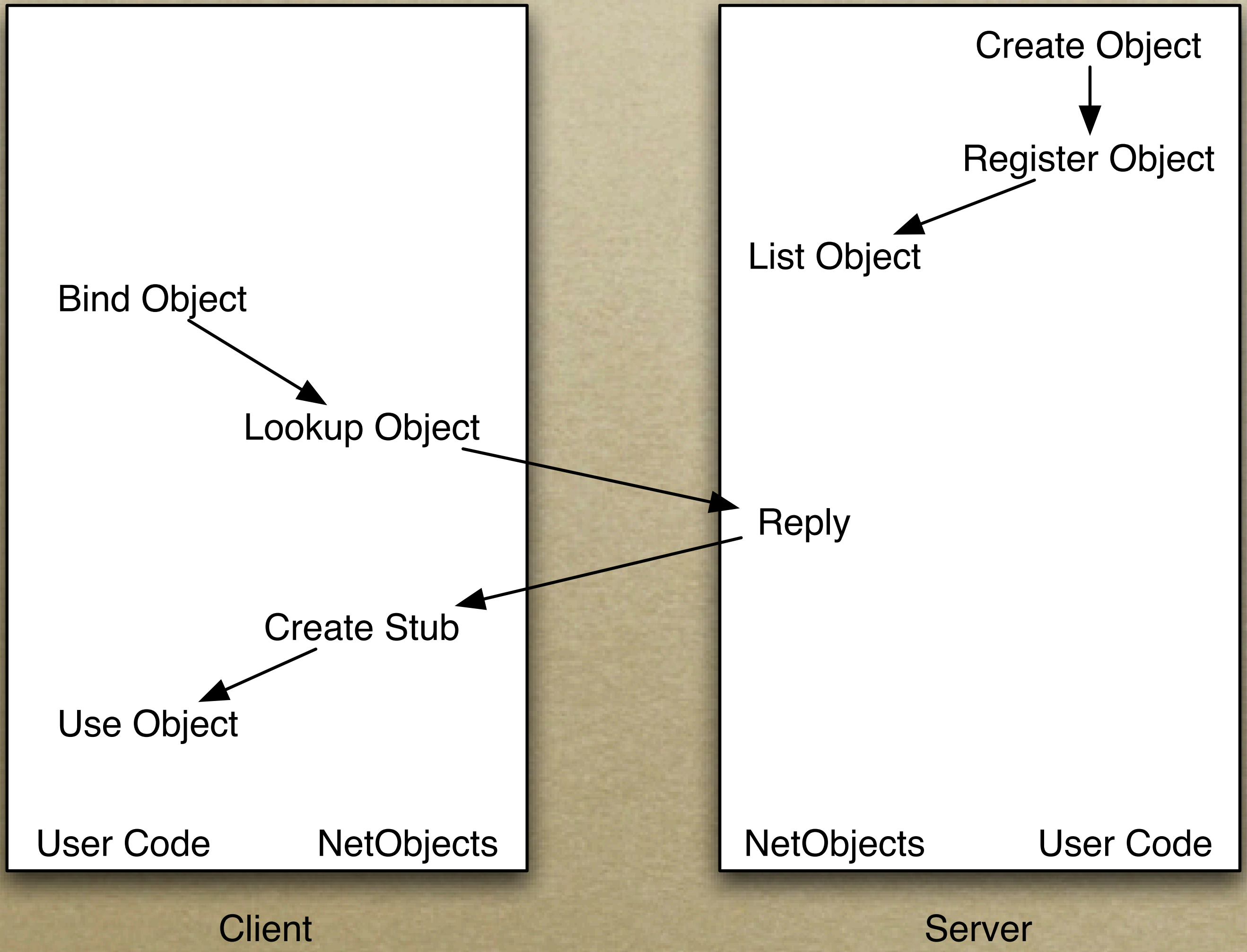
Can we do better?

- *Object oriented languages exist.*
- *Can we abstract objects?*
  - *If we can abstract methods, why not?*
  - *Object mobility*
- *Can we abstract data?*
  - *Do we care where code runs?*

Network Objects: RPC++

- *RPC allows us to virtualize a method.*
- *Why not virtualize the whole object?*
- *Network objects implement this idea.*

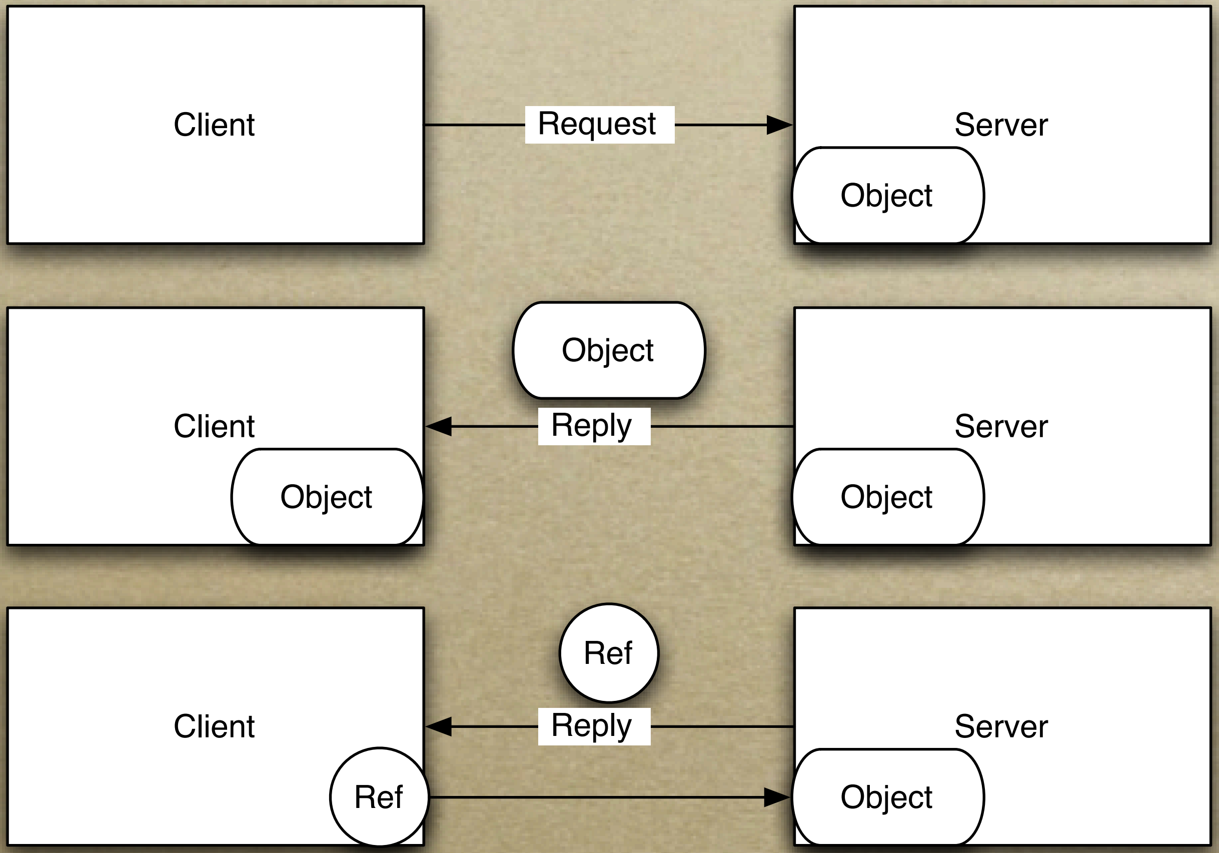
Deja Vu


Create Object
Register Object
List Object
Bind Object
Lookup Object
Reply
Create Stub
Use Object
User Code
NetObjects
NetObjects
User Code
Client
Server

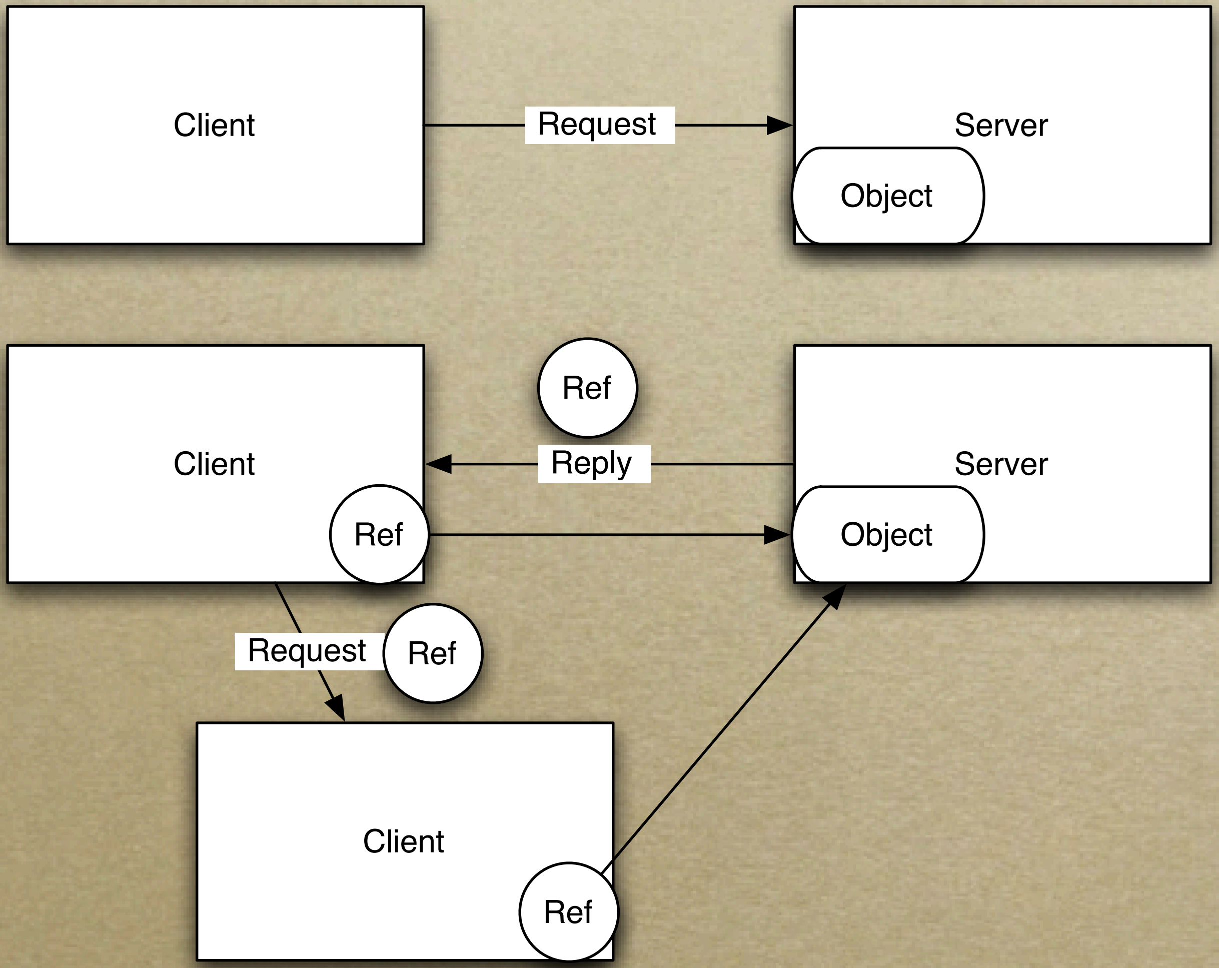
Why Objects?

- *RPC can’t pass pointers.*
  - *Centralized data structures become complicated.*
- *RPC has problems with interactable data structures.*
  - *Streams, Sockets, …*

Getting from here to there...



Share the love



The fine print

- *To Send or to Reference?*
    - *Tag each class as sendable or not.*
- *How can unknown classes be encoded?*
    - *Use Introspection to break a class down.*
- *How do you encode special datatypes?*
    - *Add hooks to let a class to encode itself.*
- *How do target machines know what code to run?*

Is RPC/NetObjects worth it?

- *Can we really trick the programmer?*
  - *Programmers need to know about network issues.*
  - *Hello world can fail.*
- *Does it matter?*
  - *With minor changes, most error conditions can be detected.*
    - *This breaks the abstraction.*
  - *Reliability is a problem.*
    - *Programmers lose fine-grained control.*

Applications

- *Network Objects has been used in several projects.*
- *Packagetool*
  - *A dpkg-like tool*
- *Siphon*
  - *A repository merge tool*

Linda

- *We’ve seen tools that are used for distributed computing...*
- *But what is distributed computing?*
  - *A task is broken down into smaller tasks.*
  - *Each processor takes on a subtask.*

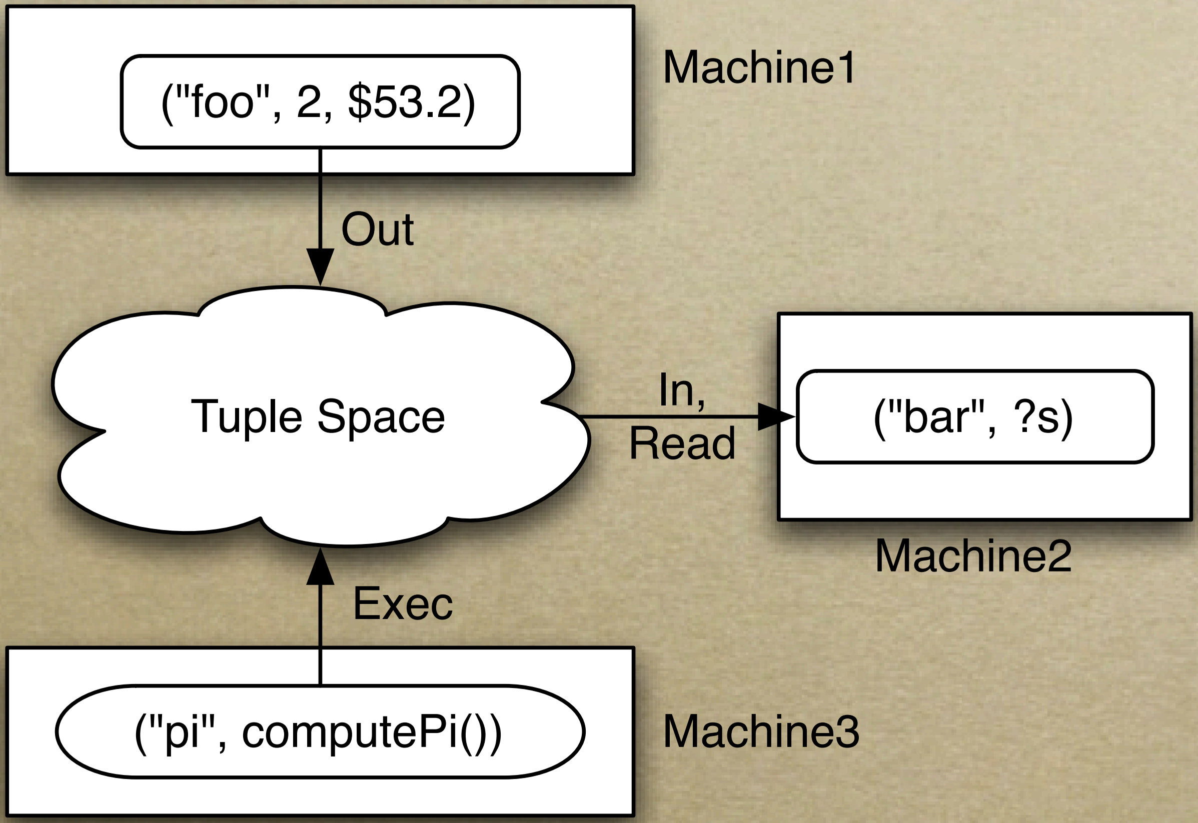
Approaches to Distribution

- *Let a compiler figure out how to parallelize.*
  - *Can code be parallelized?*
- *RPC: Central system issues commands to processing servers.*
- *Producer/Consumer*
  - *Producers need to know who the consumers are or visa versa*

Tuple Space

- *A tuple is analogous to a C struct.*
- *We can create a distributed database.*
- *The database can store tuples.*
- *We can create tasks that exist to create more tuples.*

Tuple Space


("foo", 2, $53.2)
Machine1
Out
Tuple Space
In,
Read
("bar", ?s)
Machine2
Exec
("pi", computePi())
Machine3

Searching Tuple Space

- *Tuple Space queries are done via pattern matching.*
- *?, the formal operator.*
- *(“foo”, ?x) would match (“foo”, 3) and would set x to 3 (if x is an int).*
    - *Matching is done by type and length.*
- *A hash table can be used to speed up lookups.*

Linda Primitives

- *Out: Create a tuple in tuple space*
- *Exec: Create a live tuple for execution*
- *Read: Find a tuple that matches a specific pattern and return its contents*
- *In: Like read, but destroy the tuple*
- *Implementations can have both blocking and nonblocking versions of read/in.*

Complex Operations

- *Operations on Tuple Space are guaranteed to be atomic and fair.*
- *Tickets: x tuples in tuple space*
- *Locks: put the locked data in a tuple*
- *Queues: drop requests into tuple space*

Mindsets

- *Linda forces programmers into a new mindset.*
- *Programs become nuggets of code.*
- *Programs become more task oriented.*
- *The idea of a program running on a single computer vanishes.*

Problems

- *Requires programmers to re-think their approach to programming.*
  - *Is this really different from other languages?*
- *Distributed databases? (Implementation isn't as easy as it seems)*
- *This approach can have a lot of overhead.*
  - *Dumb scheduling/Protection.*
  - *Synchronizing tuple access.*
- *Crash recovery?*
  - *Tuples can vanish from the system.*
  - *A "lock" held by a process might never be released.*

Implementation

- *Implementations exist on many platforms.*
- *Linda has been used in several projects:*
  - *DNA Sequencing, Raytracing, etc…*
- *Performance measurements?*

Conclusions

- *The RPC Model can be vastly improved upon.*
- *By adding objects to RPC, we can create primitives that RPC can't approach.*
- *By using a distributed database, we can let the runtime find concurrency in our programs.*
- *But is it good enough?*
    - *Networks are inherently unstable.*
    - *Abstracting away instability can have dire consequences for some applications.*