# CMSC433, Spring 2002 Programming Language Technology and Paradigms Distributed Computing & RMI

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## Administrivia

- Commentary for project 2 due next Wed.
- Project 4 posted
  - distributed computing with RMI
- Read Ch. 15, pages 973-979, in Eckel
  - Readings web page also has additional distributed computing reading
- Return and talk about exam Tuesday



## Last time - Distributed computing

- Issues
  - addressing objects
  - latency
  - partial failure
  - concurrency
- Robustness and performance requirements call for a non-uniform view of distributed objects
  - plan for failure
  - cope with latency



## Latency

- Making a call to an object on a remote machine is much more expensive than a local call
  - several orders of magnitude
- Leading to overall system performance problems if there are "too many" remote calls



## RMI

## Different Approaches to Distributed Computation

- High-performance, parallel scientific apps
- Connecting via sockets
  - custom protocols for each application
- RPC/DCOM/CORBA/RMI
  - make what looks like a normal function call
  - function is actually invoked on another machine
  - Arguments are *marshalled* for transport
  - return value is marshalled as well

## Remote Method Invocation

- Easy way to get distributed computation
- Have stub for remote object
  - calls to stub get translated into network call
- Arguments and return values can be passed over network



## Remote Objects and Interfaces

- Remote Objects are those that can be referenced remotely
  - extend **java.rmi.UnicastRemoteObject**
  - constructor throws **java.rmi.RemoteException**
- Remote interfaces describe services that can be provided remotely
  - extend **java.rmi.Remote** interface
  - all methods throw **java.rmi.RemoteException**



## RMIC - RMI Compiler

- Generates stub code for a class
  - For 1.1, also generates skeleton class
  - skeleton not needed for 1.2+
- Generates stubs for all methods declared in remote interfaces
  - other methods don't get a stub



## Passing arguments

- Can pass arbitrary values as arguments
- Can return arbitrary values as results
- To pass a value, it must implement either
  - **Serializable**, or
  - **Remote**
- Passing the same Serializable object in different calls
  - will materialize different objects at receiver



## Downloading code

- When you pass a reference to a remote class
  - receiver (the method being called) needs stub class code (class file generated by *rmic*)
- When you pass a ref to serializable class
  - receiver needs class (the class file from *javac*)
- References to remote and serializable classes annotated with *RMI codebase*
  - where code can be loaded from



## SecurityManager

- Must install some Security Manager to allow download of classes from RMI codebase
- Can use **RMISecurityManager**
  **System.setSecurityManager(new RMISecurityManager());**
- Modify policy file to grant permissions
  - example of that will be on Lectures web page

## Naming.lookup

- Naming.lookup is used to bootstrap RMI communication
  - Get your first reference to a remote object
- Someone runs an RMIRegistry
  - a separate Java VM (or can run inside a JVM also running something else)
  - that listens to a particular port (default 1099)
- Can bind/unbind/rebind name on localhost (the one running the registry)
- Can lookup name on any host



## RMI Chat server example

- Server
  - runs the chat room
- Client
  - participant in chat room
  - receives messages from others in room
- Connection
  - uniquely identifies a client
  - used to speak in chat room



## Server

```
interface Server extends Remote {
        Connection logon(String name, Client c)
                throws RemoteException;
        }
```



## Connection

```
interface Connection extends Remote {
        /** Say to everyone */
        void say(String msg)
                throws RemoteException;
        / ** Say to one person */
        void say(String who, String msg)
                throws RemoteException;
        String [] who()
                throws RemoteException;
        void logoff()
                throws RemoteException; ;
        }
```



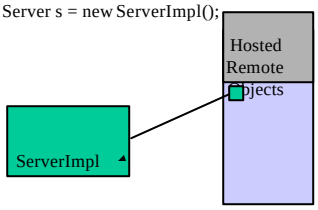
## Client

```
interface Client extends Remote {
        void said(String who, String msg)
                throws RemoteException;
        void whoChanged(String [] who)
                throws RemoteException;
        }
```

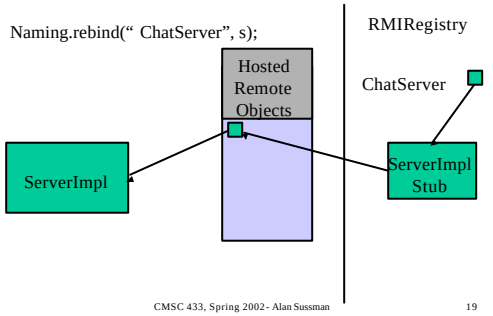


## Remote Object creation on Server host

Server s = new ServerImpl();

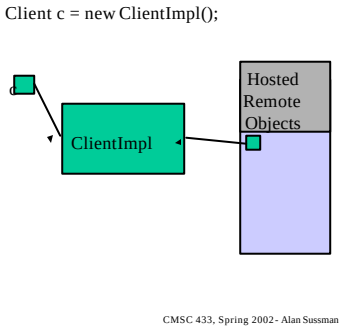


## RMI Registry on Server host



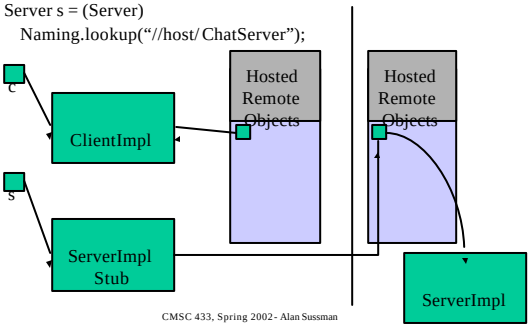



## Client creation on Client host



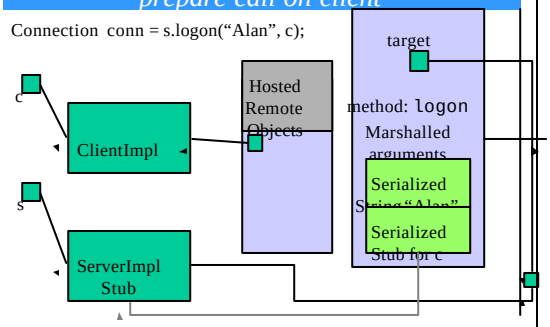



## Server Lookup on Client host



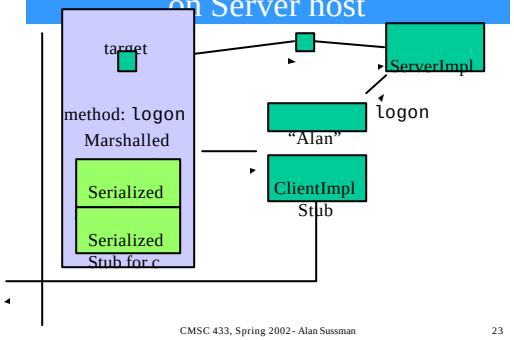



## Invoke message on Server from Client host
*prepare call on client*



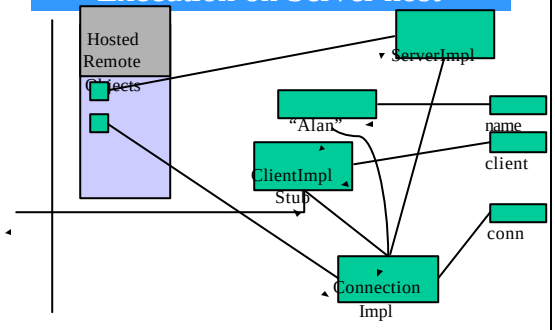


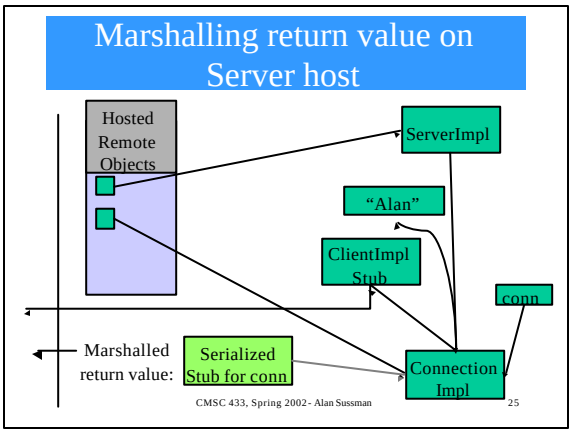

## Unmarshalling arguments on Server host






## Execution on Server host




Marshalling return value on Server host
Hosted Remote Objects
ServerImpl
"Alan"
ClientImpl Stub
conn
Marshalled return value:
Serialized Stub for conn
Connection Impl
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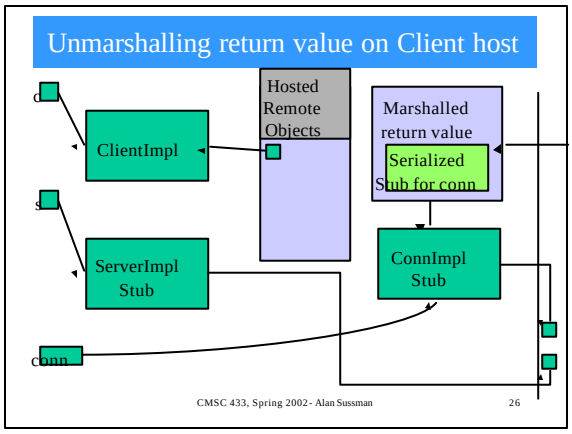
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