Remote Procedure Calls

CS587x Lecture
Department of Computer Science
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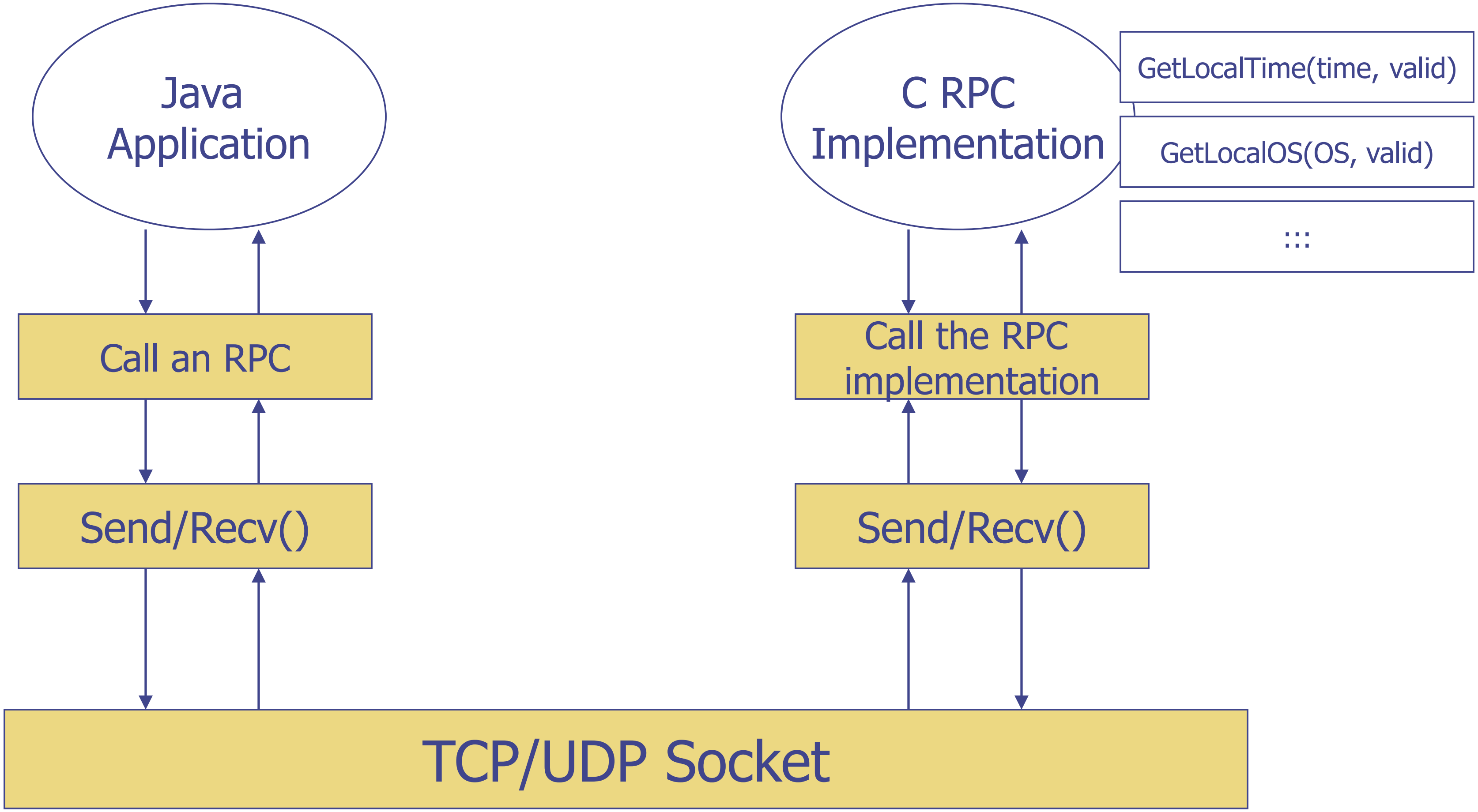
Remote Procedure Call

- What is RPC for?
  - Allowing programs to call procedures located on another machine transparently
- Scope of use
  - Distributed computing
    - Task and data partitioned environments
    - Task distribution
      - Front-end load-balances across functional back ends
  - Services
    - Client-server model
    - Mail servers, databases (transaction servers)

Java-to-C (J2C) RPC


Java Application

Call an RPC

Send/Recv()

C RPC Implementation

GetLocalTime(time, valid)

GetLocalOS(OS, valid)

:::

Call the RPC implementation

Send/Recv()

TCP/UDP Socket

Interface Design

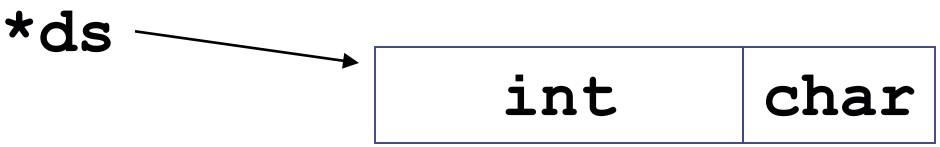
- C Interface
  - How to call its C implementation?
- Java Interface
  - How to represent a C function in Java
  - How to set inputs
  - How to execute
  - How to get outputs

C Interface Design

- Every C function is implemented as

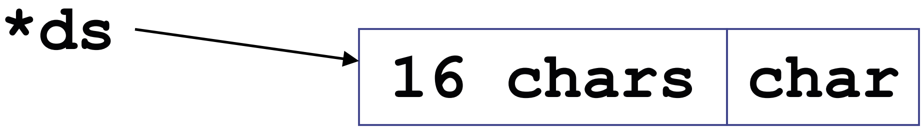
  void CmdXYZ(char *buffer), where the interpretation of buffer is determined by CmdXYZ

```
typedef struct
{
     int    time;
     char   valid;
} GET_LOCAL_TIME;

void GetLocalTime(GET_LOCAL_TIME *ds);
```



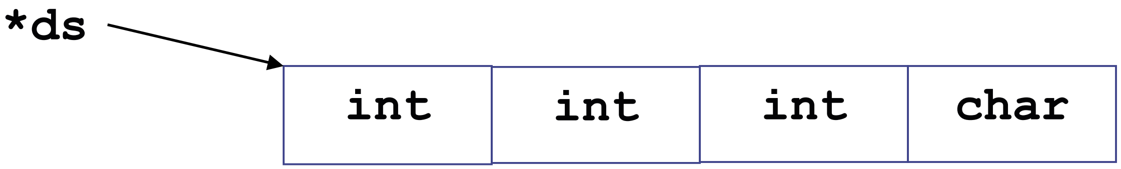
GetLocalOS(char *buffer)

```
typedef struct
{
        char  OS[16];
        char  valid;
} GET_LOCAL_OS;

void GetLocalOS(GET_LOCAL_OS *ds);
```



GetDiskData (char *buffer)

```
typedef struct {
     int DiskNumber;
     int Cylinder;
     int Sector;
     char Status;
} GET_DISK_DATA;

void GetDiskData(GET_DISK_DATA *ds);
```



Java Interface Design

- Each C function has a corresponding class

```
class GetLocaltime();
```

- Steps of making an RPC

1. Instantiate an RPC object

```
obj = new GetLocalTime();
```

2. Set inputs

```
obj.valid.setValue(FALSE);
```

3. Execute

```
obj.execute(IP, PORT);
```

4. Get outputs

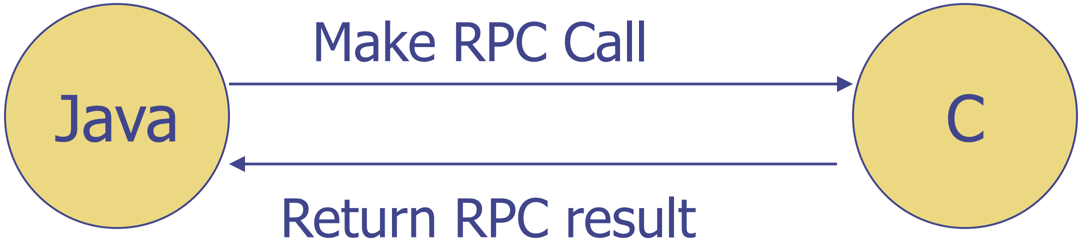
```
int t = obj.time.getValue();
```

RPC Class of GetLocalTime()

```
class GetLocalTime {
    c_int    time;
    c_char   valid;

    public int execute(string IP, int port);
}

// the representation of a c integer in java
class c_int {
    byte[] buf = byte[4]; // little endian

    public int getSize(); // the size of buf
    public int getValue();  // the int value represented by buf
    public void setValue(byte[] b); // copy the value in b into buf
    public void setValue(int v); // set buf according to v
    public byte[] toByte(); // return buf
}

// the representation of a C char (and other c types )in java {….}
```

Implementation of execute()

- Communication protocol



CmdID	CmdLength	CmdBuf

Header

- CmdID (100 bytes): the command ID
- CmdLength (4 bytes): the length of CmdBuf

CmdBuf (dynamic): the parameters to the command

Implementation of execute()

- Create a binary buffer

```
int length = time.getsize()+valid.getsize();
byte[] buf = new byte[100+4+length];
```

- Marshall parameters into the buffer

```
buf[0, 99] = “GetLocalTime”; offset = 100;
buf[100, 103] = length; offset^^;
buf[offset, time.getSize()] = time.toByte(); offset^^
buf[offset, valid.getSize()] = valid.toByte();
```

- Send/receive the buffer to/from the RPC server

```
s = CreateSocket(IP, port);
SendPacket(s, buf, buf.length());
RecvPacket(s, buf, buf.length());
```

- Set parameters according to the buffer

```
time.setValue(buf, 104);
valid.setValue(buf, 104+time.getSize());
```

C Implementation

- Wait for a connection
- When a connection arrived, launch a thread to process a command as follows:
- Receive a command

```
header = new byte[104]
RecvPacket(header, 104);
if (header[0-99] is NOT a valid command)exit;
length = header[100-103];
buf = new byte[length];
RecvPacket(s, buf, length);
```

- Execute the command

```
switch header[0-99] of
    case “GetLocalTime”:
    {
        GetLocalTime(buf);
        break;
    }
    Case “…….”:
```

- Send the command back

```
SendPacket(s, header+buf, 104+length);
```

What to submit (Java code)

- c_int.java
- c_char.java
- GetLocalTime.java:
- GetLocatIOS.java
- Test.java

```
//Test.java
main()
{
    //testing GetLocalTime
    obj = new GetLocalTime();
obj.valid.setValue(FALSE);
obj.execute(IP, PORT);
int t = obj.time.getValue();
//print out t and valid

//testing GetLocalOS
:::
}
```

What to submit (C code)

- Server.c
  1. Main
     - Wait for socket connection
     - Upon receiving a connection request, launch a thread CmdProcessor to handle the request
  2. CmdProcessor
     - Receive CmdID (100 bytes)
     - Receive CmdLength (4 bytes)
     - Receive the CmdBuffer, the size of which is specified by CmdLength
     - Call the corresponding C function and update the data in CmdBuffer
     - Send CmdID, CmdLength, and CmdBuffer back

Think Further!!!

- A new command needs to be added?
- An existing command needs to be deleted?
- Some parameters to a command need to be changed?
  - Add a new field
  - Delete an existing field
  - Change the type of an existing field