Interprocess communcation

- in Operating systems we find there are a number of mechanisms used for interprocess communication (IPC)
- the IPC mechanisms can be divided into two groups, those which work well using shared memory and those which work with non shared memory
- some common methods of IPC are: sockets, semaphores and mailboxes
- sockets and mailboxes are normally used by non shared memory programs
  - ie client and server on different machines

Interprocess communication in shared memory systems

- semaphores are more appropriate for multiple processes sharing some common memory
- we will be covering a semaphores and message passing after networking with sockets
- message passing
  - can be used in shared memory systems

Interprocess communication in non shared memory systems

- network sockets (Berkeley and System V Transport Layer Interface)
  - work well with programs (clients and servers) which do not share the same memory
- message passing
  - can be used in non shared memory systems

Berkeley Sockets

- the Berkeley interface to sockets ultimately gives the programmer a file descriptor on both client and server which can be both read from and written to
- this is elegant as the user application can map its functionality onto basic file primatives: read, write
- Berkeley sockets are available in many languages and available on most operating systems

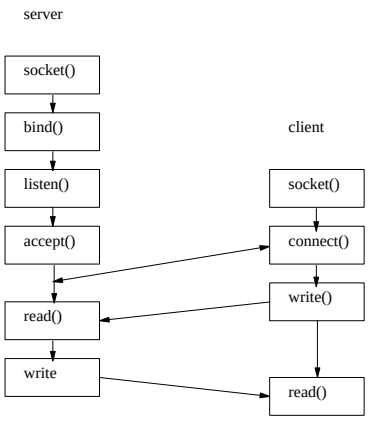
Berkeley Sockets

Program	Description	Function
server	create end point	`socket()`
	bind address	`bind()`
	specify queue	`listen()`
	wait for connection	`accept()`
client	create end point	`socket()`
	bind address	`bind()`
	connect to server	`connect()`

Berkeley Sockets

Program	Description	Function
	transfer data	`read()`
		`write()`
		`recv()`
		`send()`
	datagrams	`recvfrom()`
		`sendto()`
	terminate	`close()`
		`shutdown()`

Connection oriented sockets (TCP sockets)



Consider Python Code for a TCP Server

tcpserver.py

```
#!/usr/bin/python

from socket import *
myHost = ""
myPort = 2000

# create a socket
s = socket(AF_INET, SOCK_STREAM)
# bind it to the server port number
s.bind((myHost, myPort))
# allow 5 pending connections
s.listen(5)

while True:
    # wait for next client to connect
    connection, address = s.accept()
    data = connection.recv(1024)
    while data:
        connection.send("echo -> " + data)
        data = connection.recv(1024)
    connection.close()
```

Consider Python Code for a TCP client

- **tcpclient.py**

```
#!/usr/bin/python

import sys
from socket import *
serverHost = "localhost"
serverPort = 2000

# create a TCP socket
s = socket(AF_INET, SOCK_STREAM)

s.connect((serverHost, serverPort))
s.send("Hello world")
data = s.recv(1024)
print data
```


Testing the code

- open up an editor and type in the server Python code
- save it as `tcpserver.py`
- now open up a terminal and type
- `$ python tcpserver.py`
- make a note of the FQDN of the server

Testing the code

- open up another editor and type in the client Python code
- save it as `tcpclient.py`
- open up a terminal

Testing the code

- `$ python tcpclient.py`
- notice that both client and server are working on the same machine

Testing the code

- change the variable `serverHost` in `tcpclient.py` to the FDQN of your neighbours machine
  - and run your client again!

Application protocol using TCP

- TCP is used by many application level protocols
  - a very common one is http
- let us build a tiny web server in Python!

Tiny web server in Python

mywebserver.py

```
#!/usr/bin/python

from socket import *
myHost = ""
myPort = 2000

# create a socket
s = socket(AF_INET, SOCK_STREAM)
# bind it to the server port number
s.bind((myHost, myPort))
# allow 5 pending connections
s.listen(5)
```


Tiny web server in Python

mywebserver.py

```
while True:
    # wait for next client to connect
    connection, address = s.accept()
    data = connection.recv(1024)
    while data:
        reply = """HTTP-Version: HTTP/1.0 200 OK
Content-Length: 3012
Content-Type: text/html

<p>Hello world!</p>
<body>
"""
        connection.send(reply)
        data = connection.recv(1024)
    connection.close()
```

Testing your web server

- open up a terminal and run
- ```
  pythonmywebserver.py
  ```
- now open up a browser and enter the url ⟨`http://localhost:2000`⟩
- you should now have a start of a tiny web server

Testing your web server

- we can see that a socket is created to give us access to mangage the TCP port 2000
- in turn the program will read from the socket and form a http response
  - which is sent back to the client which renders the html after stripping it from the http packet

UDP sockets

- we can also produce a UDP client and server
  - these are functionally different to TCP servers, despite the similarity between the Python code implementation

UDP server

- ```
  #!/usr/bin/python

  from socket import *
  myHost = ""
  myPort = 2000

  # create a UDP socket
  s = socket(AF_INET, SOCK_DGRAM)
  # bind it to the server port number
  s.bind((myHost, myPort))

  data, address = s.recvfrom(1024)
  while data:
      print "UDP server:", data, "from", address
      s.sendto("echo -> " + data, address)
      data, address = s.recvfrom(1024)
  ```

UDP client

udpclient.py

```
#!/usr/bin/python

import sys
from socket import *
serverHost = "localhost"
serverPort = 2000

# create a UDP socket
s = socket(AF_INET, SOCK_DGRAM)

s.connect((serverHost, serverPort))
s.send("Hello world")
data = s.recv(1024)
print data
```