Network Programming with Python

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Python 101

Python Standard Types

- Numbers: `1, 122L, 2.0, 1e+2j`
- Strings: `'Python', ''PROGRES''`
- Lists: `[123, 'ABC']`
- Tuples: `(123, 'ABC')`
- Dictionaries: `{'num': 123, 'str': 'ABC'}`

Python Subscripting

```
str = "PROGRES"

print(str[2:4])

print(str[2:])

print(str[-1:])


l = [1,2,3,4,5]

print(l[2:4])

print(l[2:])

print(l[-1:])
```

Python Subscripting

```
str = "PROGRES"
print(str[2:4])
print(str[2:])
print(str[-1:])

l = [1,2,3,4,5]
print(l[2:4])
print(l[2:])
print(l[-1:])
```

```
OG
OGRES
S
[3, 4]
[3, 4, 5]
[5]
```

Python Operators

- Arithmetic: `+,-,*,/,%,**,//`
- Comparison: `==,!=,<>,>,<,>=,<=`
- Assignment: `=,+=,-=,*=,/=,%=,**=,//=`
- Logical: `and, or, not`
- Bitwise: `&,|,~,<<,>>`
- Membership: `in, not in`
- Identity: `is, is not`

Python Conditions

```
var1 = 100
if var1:
   print ("1 - Got a true expression value")
   print (var1)
else:
   print ("1 - Got a false expression value")
   print (var1)
var2 = 0
if var2:
   print ("2 - Got a true expression value")
   print (var2)
else:
   print ("2 - Got a false expression value")
   print (var2)
print ("Good bye!")
```

Python Conditions

```
var1 = 100
if var1:
   print ("1 - Got a true expression value")
   print (var1)
else:
   print ("1 - Got a false expression value")
   print (var1)
var2 = 0
if var2:
   print ("2 - Got a true expression value")
   print (var2)
else:
   print ("2 - Got a false expression value")
   print (var2)
print ("Good bye!")
```

```
1 - Got a true expression value
100
2 - Got a false expression value
0
Good bye!
```

Python While Loop

```
count = 0

while (count < 9):

    print ('The count is:', count)

    count = count + 1

print ("Good bye!")
```

Python While Loop

```
count = 0

while (count < 9):

    print ('The count is:', count)

    count = count + 1

print ("Good bye!")
```

```
The count is: 0
The count is: 1
The count is: 2
The count is: 3
The count is: 4
The count is: 5
The count is: 6
The count is: 7
The count is: 8
Good bye!
```

Python For Loop

```
for letter in 'Python':

   print ('Current Letter :', letter)

fruits = ['banana', 'apple',  'mango']

for fruit in fruits:

   print ('Current fruit :', fruit)

fruits = ['banana', 'apple',  'mango']

for index in range(len(fruits)):

   print ('Current fruit :', fruits[index])
```

Python For Loop

```
for letter in 'Python':

   print ('Current Letter :', letter)

fruits = ['banana', 'apple',  'mango']

for fruit in fruits:

   print ('Current fruit :', fruit)

fruits = ['banana', 'apple',  'mango']

for index in range(len(fruits)):

   print ('Current fruit :', fruits[index])
```

```
Current Letter : P
Current Letter : y
Current Letter : t
Current Letter : h
Current Letter : o
Current Letter : n
```

```
Current fruit : banana
Current fruit : apple
Current fruit : mango
```

```
Current fruit : banana
Current fruit : apple
Current fruit : mango
```

Python Exceptions

```
try:
 // dangerous code
except ExceptionName:
 // code to handle the problem related
 // to the ExceptionName event
```

Python Exceptions

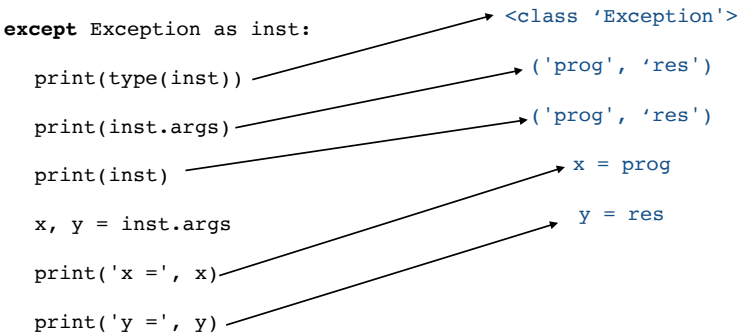
```
from sys import *
try:
    f = open('myfile.txt')
    s = f.readline()
    i = int(s.strip())
except OSError as err:
    print("OS error: {0}".format(err))
except ValueError:
    print("Could not convert data to an integer.")
except:
    print("Unexpected error:", sys.exc_info()[0])
    raise
```

Python Exceptions

```
try:
   raise Exception('prog','res')
except Exception as inst:
   print(type(inst))
   print(inst.args)
   print(inst)
   x, y = inst.args
   print('x =', x)
   print('y =', y)
```

Python Exceptions

```
try:
   raise Exception('prog','res')
except Exception as inst:
   print(type(inst))
   print(inst.args)
   print(inst)
   x, y = inst.args
   print('x =', x)
   print('y =', y)
```



Python Functions

```
def sum(arg1,arg2):
    res = arg1+arg2
    return res


print(sum(2,2))
```

Python Functions

```
def sum(arg1,arg2):
    res = arg1+arg2
    return res


print(sum(2,2)) ——→ 4
```

Python Functions

```
res=0
def sum(arg1,arg2):
    res = arg1+arg2
    return res


print(sum(2,2))
print(res)
```

Python Functions

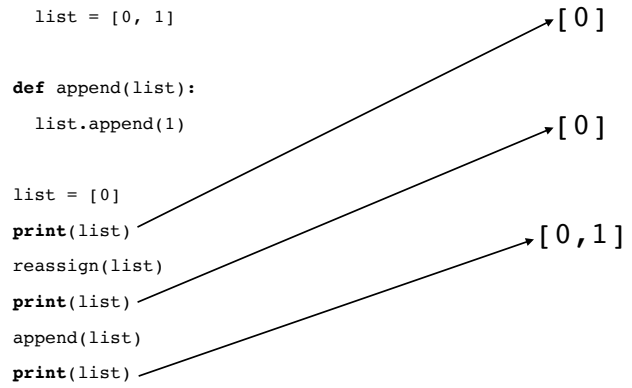
```
res=0
def sum(arg1,arg2):
    res = arg1+arg2
    return res


print(sum(2,2)) ——→ 4
print(res) ——→ 0
```

Python Functions

```
def reassign(list):
  list = [0, 1]

def append(list):
  list.append(1)

list = [0]
print(list)
reassign(list)
print(list)
append(list)
print(list)
```

Python Functions

```
def reassign(list):
  list = [0, 1]

def append(list):
  list.append(1)

list = [0]
print(list)
reassign(list)
print(list)
append(list)
print(list)
```



Python Modules

myfuncs.py

```
def add(arg1,arg2):
    return arg1+arg2
```

usemyfuncs.py

```
import myfuncs
print(myfuncs.add(2,2))
```

Python Modules

myfuncs.py

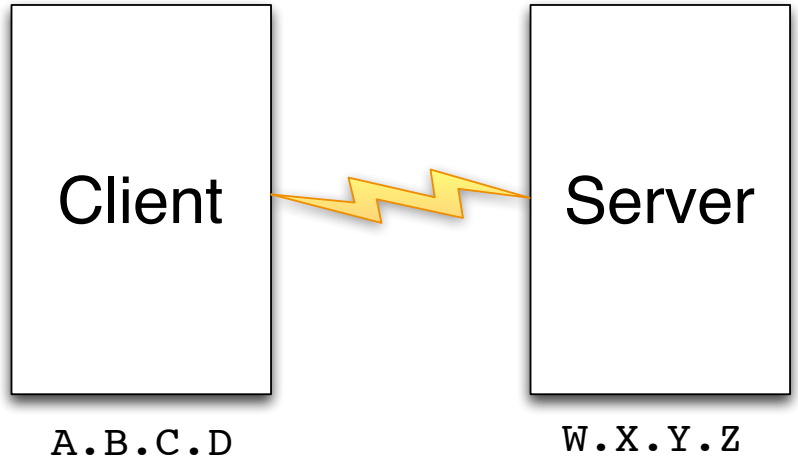
```
def add(arg1,arg2):
    return arg1+arg2
```

usemyfuncs.py

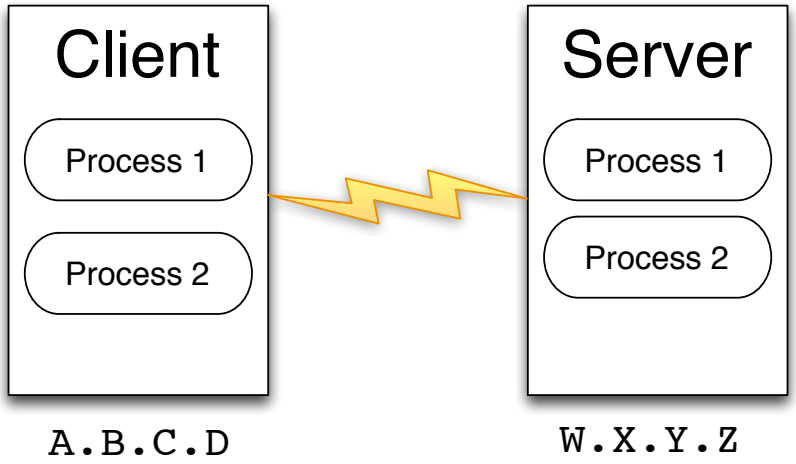
```
from myfuncs import *
print(add(2,2))
```

Client-Server

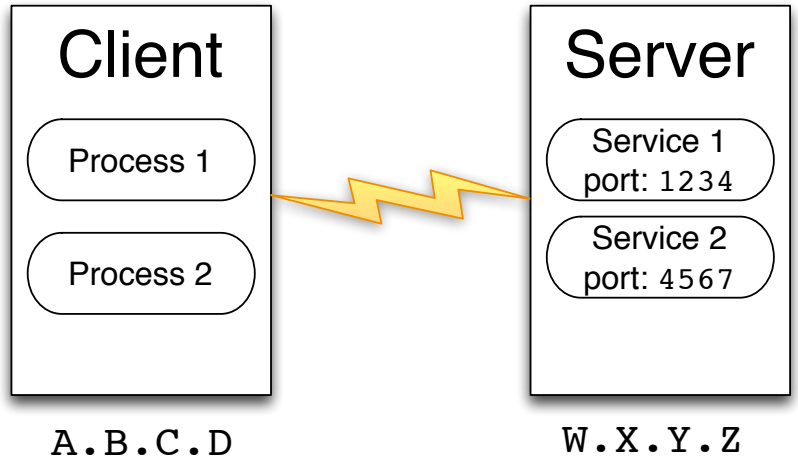
Addressing



Addressing



Client-Server

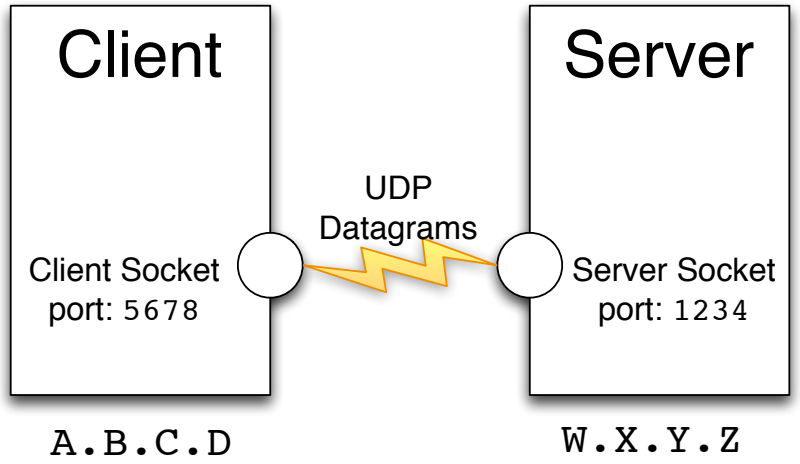


Client-Server

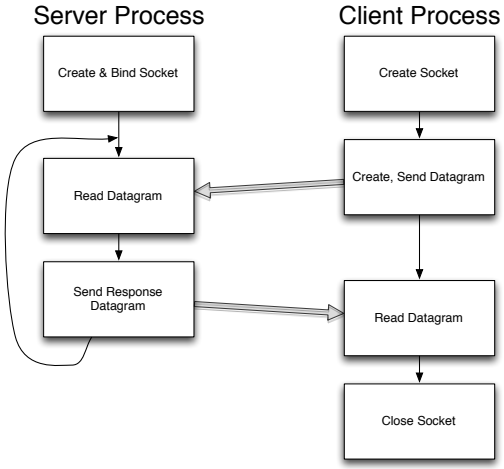
- Two processes, **client** and **server**, are executed on (possibly) different machines
- The server **awaits** connections and provides a service
- The client **connects** to the server to request a service
- A particular process can be both client and server (possibly) for different services

UDP Sockets

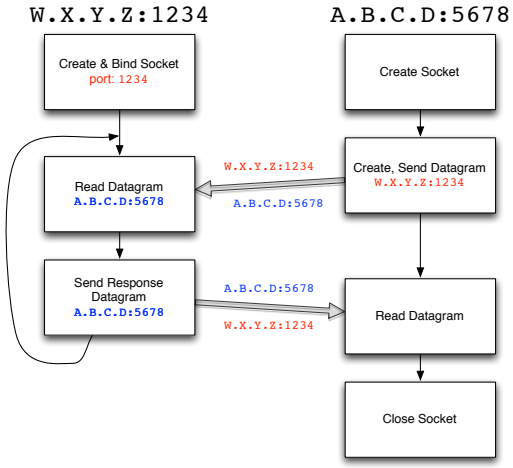
UDP Sockets



UDP Client-Server



UDP Client-Server



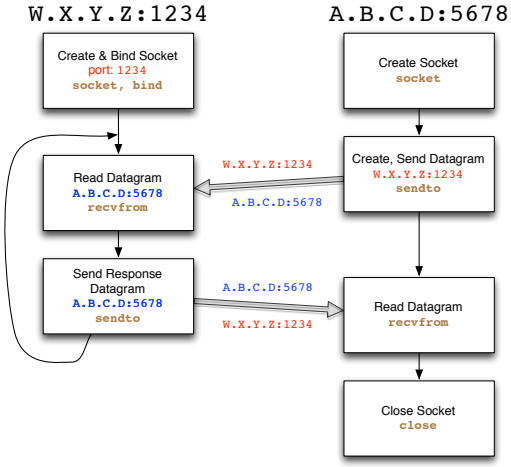
UDP Python Client

```
from socket import *

serverName = 'A.B.C.D'

serverPort = 1234

clientSocket = socket(AF_INET,SOCK_DGRAM)

message = input('lowercase sentence:')

clientSocket.sendto(message,(serverName,serverPort))

modifiedMessage, serverAddress = clientSocket.recvfrom(2048)

print(modifiedMessage)

clientSocket.close()
```

UDP Python Server

```
from socket import *

serverPort = 1234

serverSocket = socket(AF_INET,SOCK_DGRAM)

serverSocket.bind(('',serverPort))

print('server ready')

while True:

 message, clientAddress = serverSocket.recvfrom(2048)

 modifiedMessage = message.upper()

 serverSocket.sendto(modifiedMessage,clientAddress)
```

UDP Client-Server



Strings and Bytes

Strings vs. Bytes

- **Strings** are meant for general Unicode support in Python 3
- **Bytes** are what is sent/received through the network
- **Encoding** of Strings into Bytes before sending

```
toSend = str.encode('utf-8')
```

- **Decoding** Bytes into Strings when receiving

```
str = received.decode('utf-8')
```

UDP Python Client

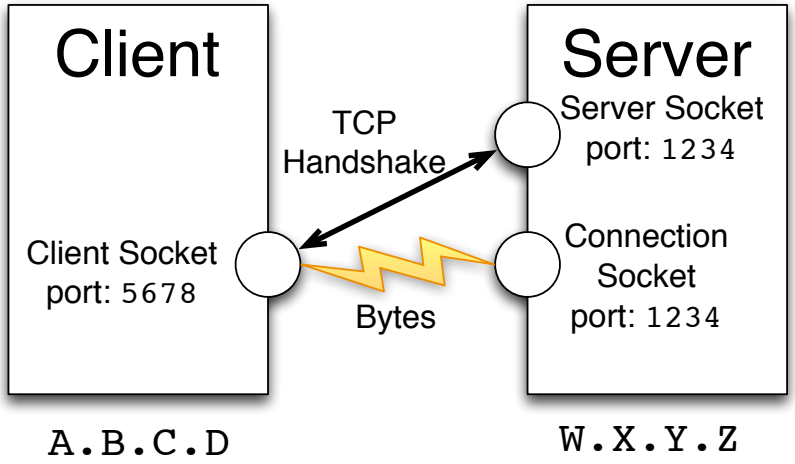
```
from socket import *

serverName = 'A.B.C.D'

serverPort = 1234

clientSocket = socket(AF_INET,SOCK_DGRAM)

message = input('lowercase sentence:').encode('utf-8')

clientSocket.sendto(message,(serverName,serverPort))

modifiedMessage, serverAddress = clientSocket.recvfrom(2048)

print(modifiedMessage.decode('utf-8'))

clientSocket.close()
```

UDP Python Server

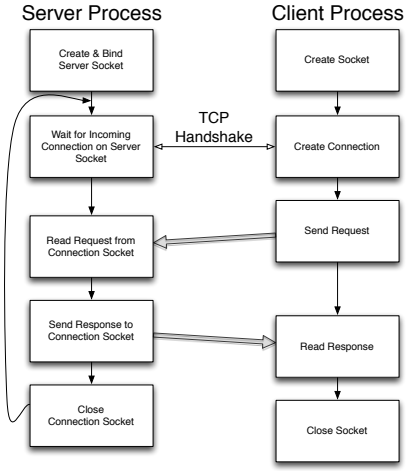
```
from socket import *

serverPort = 1234

serverSocket = socket(AF_INET,SOCK_DGRAM)

serverSocket.bind(('',serverPort))

print('server ready')

while True:

 message, clientAddress = serverSocket.recvfrom(2048)

 modifiedMessage = message.decode('utf-8').upper()

 serverSocket.sendto(modifiedMessage.encode('utf-8'),
clientAddress)
```

TCP Sockets

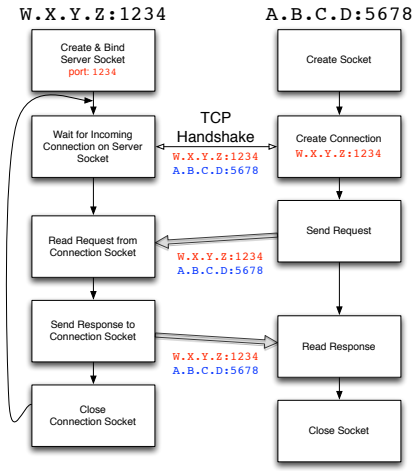
TCP Sockets



TCP Client-Server



TCP Client-Server



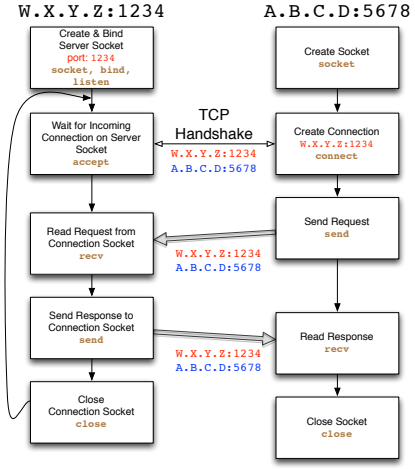
TCP Python Client

```
from socket import *
serverName = 'A.B.C.D'
serverPort = 1234
clientSocket = socket(AF_INET,SOCK_STREAM)
clientSocket.connect((serverName,serverPort))
message = input('lowercase sentence:').encode('utf-8')
clientSocket.send(message)
modifiedMessage = clientSocket.recv(2048).decode('utf-8')
print(modifiedMessage)
clientSocket.close()
```

TCP Python Server

```
from socket import *
serverPort = 1234
serverSocket = socket(AF_INET,SOCK_STREAM)
serverSocket.bind(('',serverPort))
serverSocket.listen(1)
print('server ready')
while True:
  connectionSocket, address = serverSocket.accept()
  message = connectionSocket.recv(2048).decode('utf-8')
  modifiedMessage = message.upper().encode('utf-8')
  connectionSocket.send(modifiedMessage)
  connectionSocket.close()
```

TCP Client Server



IPv4 and IPv6

IPv4 Names

```
from socket import *

print(gethostname())

print(getfqdn())

print(gethostbyname('lip6.fr'))

print(gethostbyaddr('132.227.104.15'))

print(gethostbyname(getfqdn()))
```

IPv4 Names

```
from socket import *

print(gethostname())

print(getfqdn())

print(gethostbyname('lip6.fr'))

print(gethostbyaddr('132.227.104.15'))

print(gethostbyname(getfqdn()))
```

```
postetixeuil4.rsr.lip6.fr

postetixeuil4.rsr.lip6.fr

132.227.104.15

('ww.lip6.fr', ['15.104.227.132.in-addr.arpa'], ['132.227.104.15'])

132.227.84.244
```

IPv4-IPv6 Names

```
infolist = getaddrinfo('lip6.fr','www')

print(infolist)

info = infolist[1]

print(info)

s = socket(*info[0:3])

s.connect(info[4])
```

IPv4-IPv6 Names

```
infolist = getaddrinfo('lip6.fr','www')

print(infolist)

info = infolist[1]

print(info)

s = socket(*info[0:3])

s.connect(info[4])
```

```
[(<AddressFamily.AF_INET: 2>,
<SocketKind.SOCK_DGRAM: 2>, 17,
'', ('132.227.104.15', 80)),
(<AddressFamily.AF_INET: 2>,
<SocketKind.SOCK_STREAM: 1>, 6,
'', ('132.227.104.15', 80))]

(<AddressFamily.AF_INET: 2>,
<SocketKind.SOCK_STREAM: 1>, 6,
'', ('132.227.104.15', 80))
```

Numbers and Byte Order

Byte Order over the Network

```
from struct import *

print(hex(1234))

print(pack('<i',1234))
print(pack('>i',1234))
print(pack('!i',1234))

print(unpack('>i',b'\x00\x00\x04\xd2'))

print(unpack('!i',b'\x00\x00\x04\xd2'))
```

Byte Order over the Network

```
from struct import *

print(hex(1234))                          → 0x4d2

print(pack('<i',1234))                    → b'\xd2\x04\x00\x00'
print(pack('>i',1234))                    → b'\x00\x00\x04\xd2'
print(pack('!i',1234))                    → b'\x00\x00\x04\xd2'

print(unpack('>i',b'\x00\x00\x04\xd2'))   → (1234,)

print(unpack('!i',b'\x00\x00\x04\xd2'))   → (1234,)
```

Network Exceptions

Network Exceptions

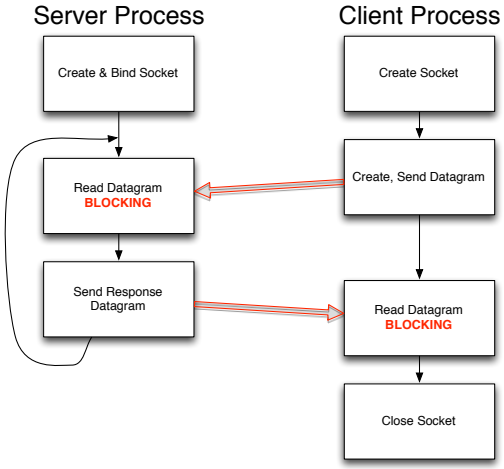
- `OSError`: almost every failure that can happen during a network connection
- `socket.gaierror`: address-related error
- `socket.timeout`: timeout expired

Network Exceptions

```
from socket import *


try:
    infolist = getaddrinfo('nonexistent.com','www')
except gaierror:
    print("This host does not seem to exist")
```

UDP Packet Drops

UDP Packet Drops



UDP Packet Drops

```
…
delay = 0.1 # sec
while True:
  clientSocket.sendto(message,(serverName,serverPort))
  clientSocket.settimeout(delay)
  try:
    modifiedMessage, serverAddress = clientSocket.recvfrom(2048)
  except socket.timeout:
    delay *= 2
  else:
    break
print(modifiedMessage.decode('utf-8'))
clientSocket.close()
```

UDP Packet Drops

```
…
delay = 0.1 # sec
while True:
  clientSocket.sendto(message,(serverName,serverPort))
  clientSocket.settimeout(delay)
  try:
    modifiedMessage, serverAddress = clientSocket.recvfrom(2048)
  except socket.timeout:
    delay *= 2
    if delay > 2.0:
      raise RuntimeError('server seems down')
  else:
    break
print(modifiedMessage.decode('utf-8'))
```

UDP Broadcast

UDP Broadcast Client

```
from socket import *
broadcastAddr = 'W.X.Y.255' # assuming 255.255.255.0 netmask
serverPort = 1234
clientSocket = socket(AF_INET,SOCK_DGRAM)
clientSocket.setsockopt(SOL_SOCKET,SO_BROADCAST,1)
message = input('lowercase sentence:').encode('utf-8')
clientSocket.sendto(message,(serverName,serverPort))
modifiedMessage, serverAddress = clientSocket.recvfrom(2048)
print(modifiedMessage.decode('utf-8'))
clientSocket.close()
```

UDP Broadcast Server

```
from socket import *

serverPort = 1234

serverSocket = socket(AF_INET,SOCK_DGRAM)

serverSocket.bind(('',serverPort))

print('server ready')

while True:

 message, clientAddress = serverSocket.recvfrom(2048)

 modifiedMessage = message.decode('utf-8').upper()

 serverSocket.sendto(modifiedMessage.encode('utf-8'),
 clientAddress)
```

TCP Sending

TCP `send`

- If TCP/IP stack has enough room, `send` returns immediately, and the **complete** message will be handled
- If TCP/IP stack is full, `send` is **blocking**
- If TCP/IP stack is **almost** full, `send` returns immediately, but only a **part** of the message will be handled

TCP `send` Loop

```
…

message=input('lowercase sentence:').encode('utf-8')

bytes_sent = 0

while bytes_sent < len(message):

  message_remaining = message[bytes_sent:]

  bytes_sent +=
  clientSocket.send(message_remaining)

…
```

TCP `sendall`

…

```
message = input('lowercase
sentence:').encode('utf-8')

clientSocket.sendall(message)
```

…

TCP Receiving

TCP `recv`

- If TCP/IP stack is full enough, `recv` returns immediately, and the **specified size** message will be delivered
- If TCP/IP stack is empty, `recv` is **blocking**
- If TCP/IP stack is not empty, `recv` returns immediately, but only a **fraction** of the specified size will be delivered

TCP `recvall` ?

- Deciding when **all** data is received is **application specific**
  - Fixed size messages
  - Message size is announced before data is sent
  - Special delimiters announce end of data

Framing and Quoting

TCP `recvall`

```
def recvall(sock, length):

    blocks = []

    while length:

        block = sock.recv(length)

        if not block:

            raise EOFError('socket closed with %d bytes left'
                           ' in this block'.format(length))

        length -= len(block)

        blocks.append(block)

    return b''.join(blocks)
```

Sending a Block

```
from struct import *
from socket import *

header_struct = Struct('!I')

def put_block(sock, message):

    block_length = len(message)

    sock.sendall(header_struct.pack(
        block_length))

    sock.sendall(message)
```

Receiving a Block

```
from struct import *
from socket import *

header_struct = Struct('!I')

def get_block(sock):

    data = recvall(sock, header_struct.size)

    (block_length,) = header_struct.unpack(data)

    return recvall(sock, block_length)
```

Files and Directories

Pathlib

- Possible issues when dealing with files :
  - OS conventions: \ vs /
  - Absolute vs. relative
  - Search for specific files
  - Concatenation

Pathlib

- Useful methods: `exists`, `is_file`, `is_dir`, …
- Simple Construction:
  - `Path('tempdir') / Path('tempfile')`

Pathlib

```
from pathlib import Path
d = Path('.')
file = Path('test.txt')
if d.is_file():
    print(f"{d} is a file.")
elif d.is_dir():
    print(f"{d} is a dir.")
if file.is_file():
    print(f"{file} is a file.")
elif file.is_dir():
    print(f"{file} is a dir.")
```

Pathlib

```
from pathlib import Path
d = Path('.')
file = Path('test.txt')
if d.is_file():
    print(f"{d} is a file.")
elif d.is_dir():
    print(f"{d} is a dir.")
if file.is_file():
    print(f"{file} is a file.")
elif file.is_dir():
    print(f"{file} is a dir.")
```

. is a dir.

test.txt is a file.

Pathlib

```
from pathlib import Path
d = Path('.')
file = Path('test.txt')
if d.is_file():
    print(f"{d} is a file.")
elif d.is_dir():
    print(f"{d} is a dir.")
if file.is_file():
    print(f"{file} is a file.")
elif file.is_dir():
    print(f"{file} is a dir.")
```

. is a dir.

test.txt is a file.

Pathlib

```
d = Path('.')
for file in d.rglob('*'):
    if file.is_file():
        print(f"{file} is a file.")
    elif file.is_dir():
        print(f"{file} is a dir.")
```

Pathlib

```
d = Path('.')
for file in d.rglob('*'):
    if file.is_file():
        print(f"{file} is a file.")
    elif file.is_dir():
        print(f"{file} is a dir.")
```

```
.DS_Store is a file.
d1 is a dir.
d2 is a dir.
test.txt is a file.
.ipynb_checkpoints is a dir.
pathlib.ipynb is a file.
d2/.DS_Store is a file.
d2/d21 is a dir.
.ipynb_checkpoints/pathlib-checkpoint.ipynb is a file.
```

Context Managers

```
def get_txt():
    f = open('test.txt', 'rb')
    txt = f.read().decode('utf8')
    f.close()
    return txt
get_txt()
```

Context Managers

```
def get_txt():
    with open('test.txt', 'rb') as f:
        return f.read().decode('utf8')
get_txt()
```

Compression

Python Data Compression

```
from zlib import *
str = b'A very long test string to evaluate compression and how much it improves
bandwidth usage'
print(len(str))

data = compress(str)
print(data)
print(len(data))

d = decompressobj()
newdata = d.decompress(data)
print(newdata)
```

Python Data Compression

```
from zlib import *

str = b'A very long test string to evaluate compression and how much it improves
bandwidth usage'

print(len(str))
```

```
88
```

```
data = compress(str)

print(data)
```

```
b'x\x9c\x15\xc9\xd1\t\xc0
\x0c\x05\xc0U\xde*\x1d%\xd5\xa0\x015%
\x89J\xb7\xaf\xfd;
\xb8\x0b\x8b\xedE\xd3Q\x10\xec\x01\x0f\x93\xdf\
n^\xd4&\x05#i\x7f\x8c\xddE\x07hdT\xdd\xe83UH@N\
xe9b\xc7}fK\x8e\x8a\xe9T\xf8\x03\xad\\!\x05'
```

```
print(len(data))
```

```
78
```

```
d = decompressobj()

newdata = d.decompress(data)

print(newdata)
```

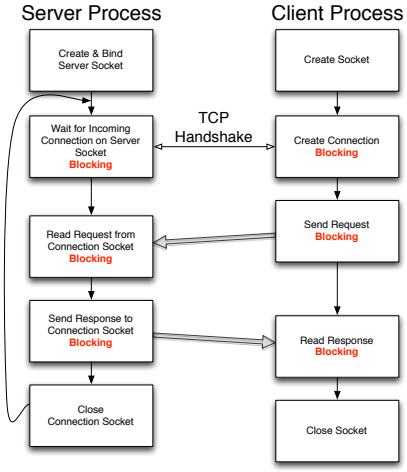
```
b'A very long test string to evaluate
compression and how much it improves bandwidth
usage'
```

Server-side Programming

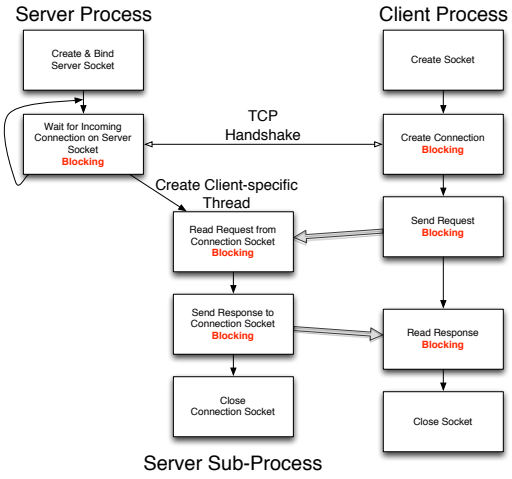
Sequential TCP Server

```
…
def handle_client(clientSocket):

    while True:

        received = clientSocket.recv(4096)

        if not received:

            clientSocket.close()

        else:

            to_send = received.decode('utf-8').upper().encode('utf-8')

            clientSocket.sendall(to_send)


while True:

        connectionSocket, address = serverSocket.accept()

        handle_client(connectionSocket)
```

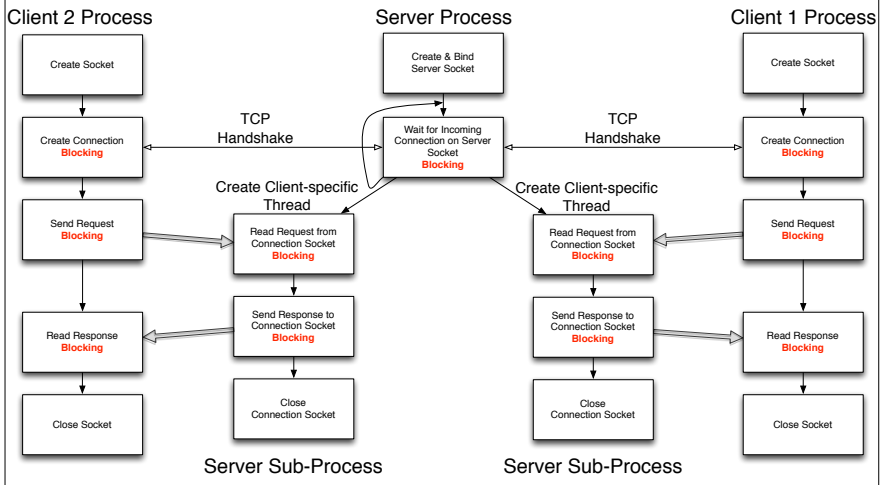
Sequential TCP Server



Multi-thread TCP Server



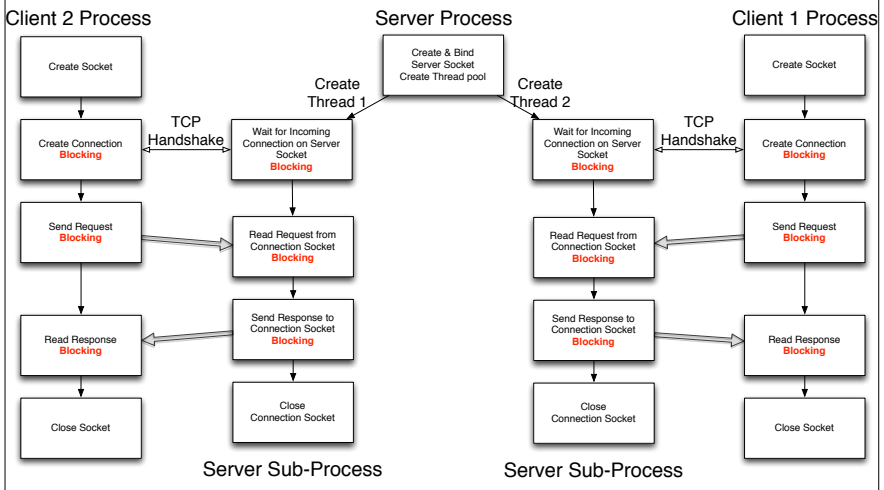
Multi-thread TCP Server



Multi-Thread TCP Server

```
from threading import *
…
def handle_client(clientSocket):
    while True:
        received = clientSocket.recv(4096)
        if not received:
            clientSocket.close()
        else:
            to_send = received.decode('utf-8').upper().encode('utf-8')
            clientSocket.sendall(to_send)
while True:
        connectionSocket, address = serverSocket.accept()
        Thread(target=handle_client,args=(connectionSocket,)).start()
```

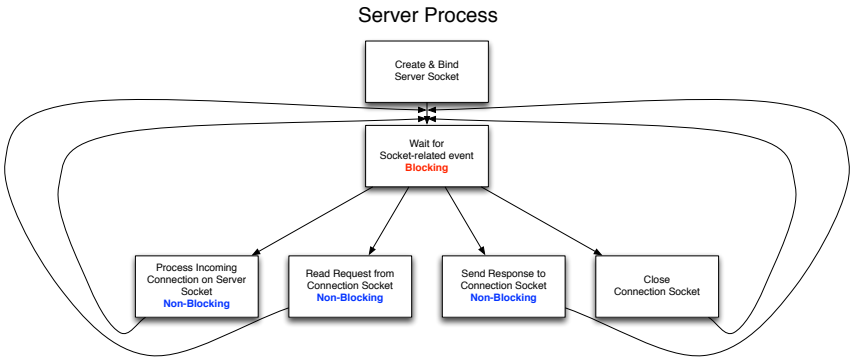
Thread Pool TCP Server



Thread Pool TCP Server

```
…
def handle_client(listeningSocket):
    while True:
        clientSocket, address = listeningSocket.accept()
        while True:
            received = clientSocket.recv(4096)
            if not received:
                clientSocket.close()
            else:
                to_send = received.decode('utf-8').upper().encode('utf-8')
                clientSocket.sendall(to_send)
for i in range(4):
        Thread(target=handle_client,args=(serverSocket,)).start()
```

Multiplexing TCP Server



Multiplexing TCP Server

```
from select import *
…
my_poll = poll()
my_poll.register(serverSocket,POLLIN)

sockets = {serverSocket.fileno(): serverSocket}
  # retrieve socket object from fileno
received = dict()
  # bytes received from fileno, that are not yet processed
to_send = dict()
  # bytes to be sent from fileno, that have been processed
```

Multiplexing TCP Server

```
while True:
    for fd, event in my_poll.poll():
        if event & (POLLHUP|POLLERR|POLLNVAL):
            received.pop(fd)
            to_send.pop(fd)
            my_poll.unregister(fd)
            del sockets[fd]
            sockets.pop(fd)
```

Multiplexing TCP Server

```
elif sockets[fd] is serverSocket:

    connectionSocket, address =
    serverSocket.accept()

    sockets[connectionSocket.fileno()] =
    connectionSocket

    my_poll.register(connectionSocket,
    POLLIN)
```

Multiplexing TCP Server

```
else:
            if event & POLLIN:
                data = sockets[fd].recv(4096)
                if not data:
                    sockets[fd].close()
                    continue
                if fd in received:
                    received[fd] += data
                else:
                    received[fd] = data
                my_poll.modify(fd,POLLIN|POLLOUT)
```

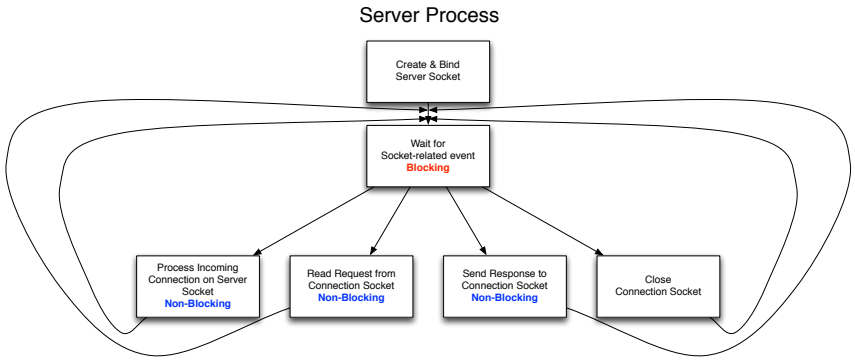
Multiplexing TCP Server

```
if event & POLLOUT:
                data = received.pop(fd).decode('utf-8')
                data = data.upper().encode('utf-8')
                if fd in to_send:
                    data = to_send.pop(fd) + data
                n = sockets[fd].send(data)
                if n < len(data):
                    to_send[fd] = data[n:]
                else:
                    my_poll.modify(fd,POLLIN)
```

Multiplexing TCP Server

```
from select import *
…
while True:
   for fd, event in my_poll.poll():
      if event & (POLLHUP|POLLERR|POLLNVAL):
       …
      elif sockets[fd] is serverSocket:
        …
      else:
          if event & POLLIN:
           …
          if event & POLLOUT:
           …
```

Multiplexing TCP Server



XML-RPC

Remote Procedure Call

- The main objective is to make client-server calls (almost) transparent to the programmer
- The server **defines a set of functions** and makes them available through the network
- The client **calls the function** (almost) as if they were local
- No need to define a protocol, a data format, etc.

Python XML-RPC Server

```
from operator import *

from math import *

from xmlrpc.server import *

from functools import *

def addtogether(*things):

    return reduce(add,things)

def quadratic(a,b,c):

    b24ac = sqrt(b*b - 4.0*a*c)

    return list((set([(-b-b24ac)/2.0*a,(-b+b24ac)/2.0*a])))
```

Python XML-RPC Server

```
…

server = SimpleXMLRPCServer(('127.0.0.1', 7001))

server.register_introspection_functions()

server.register_multicall_functions()

server.register_function(addtogether)

server.register_function(quadratic)

print("Server ready")

server.serve_forever()
```

Python XML-RPC Client

```
from xmlrpc.client import *

proxy = ServerProxy('http://
127.0.0.1:7001')

print(proxy.addtogether('x','y','z'))

print(proxy.addtogether(1,2,3,4,5))

print(proxy.quadratic(2,-4,0))

print(proxy.quadratic(1,2,1))
```

Python XML-RPC Client

```
from xmlrpc.client import *

proxy = ServerProxy('http://
127.0.0.1:7001')

print(proxy.addtogether('x','y','z'))  → xyz

print(proxy.addtogether(1,2,3,4,5))  → 15

print(proxy.quadratic(2,-4,0))  → [0.0, 8.0]

print(proxy.quadratic(1,2,1))  → [-1.0]
```

Wireshark

```
POST /RPC2 HTTP/1.1
Host: 127.0.0.1:7001
Accept-Encoding: gzip
Content-Type: text/xml
User-Agent: Python-xmlrpc/3.4
Content-Length: 258

<?xml version='1.0'?>
<methodCall>
<methodName>addtogether</methodName>
<params>
<param>
<value><string>x</string></value>
</param>
<param>
<value><string>y</string></value>
</param>
<param>
<value><string>z</string></value>
</param>
</params>
</methodCall>
```

```
HTTP/1.0 200 OK
Server: BaseHTTP/0.6 Python/3.4.3
Date: Mon, 18 Jan 2016 13:41:45 GMT
Content-type: text/xml
Content-length: 129

<?xml version='1.0'?>
<methodResponse>
<params>
<param>
<value><string>xyz</string></value>
</param>
</params>
</methodResponse>
```

Wireshark

```
POST /RPC2 HTTP/1.1
Host: 127.0.0.1:7001
Accept-Encoding: gzip
Content-Type: text/xml
User-Agent: Python-xmlrpc/3.4
Content-Length: 330

<?xml version='1.0'?>
<methodCall>
<methodName>addtogether</methodName>
<params>
<param>
<value><int>1</int></value>
</param>
<param>
<value><int>2</int></value>
</param>
<param>
<value><int>3</int></value>
</param>
<param>
<value><int>4</int></value>
</param>
<param>
<value><int>5</int></value>
</param>
</params>
</methodCall>
```

```
HTTP/1.0 200 OK
Server: BaseHTTP/0.6 Python/3.4.3
Date: Mon, 18 Jan 2016 13:41:45 GMT
Content-type: text/xml
Content-length: 122

<?xml version='1.0'?>
<methodResponse>
<params>
<param>
<value><int>15</int></value>
</param>
</params>
</methodResponse>
```

Conclusion

- Python makes network programming really easy
- A number of Python modules have been developed for popular Internet-based protocols
- The socket API remains important for developing new protocols, and accessing lower layers