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Theory

Third-party libraries: Although the Python's standard library provides a great set of awesome functionalities, there will be times that you will eventually run into the need of making use of third party libraries. Can you imagine building a webserver from scratch? Or making a port to a database driver? Or, maybe, coming up with an image manipulation tool?. Third party libraries are welcome in a way that they prevent you from reinventing the something that exit. They save you time to focus on finishing and delivering your application.

Networking Glossary: Before we begin discussing networking with any depth, we must define some common terms that you will see throughout this guide, and in other guides and documentation regarding networking.

Connection: In networking, a connection refers to pieces of related information that are transferred through a network. This generally infers that a connection is built before the data transfer (by following the procedures laid out in a protocol) and then is deconstructed at the end of the data transfer.

Packet: A packet is, generally speaking, the most basic unit that is transfered over a network. When communicating over a network, packets are the envelopes that carry your data (in pieces) from one end point to the other. Packets have a header portion that contains information about the packet including the source and destination, timestamps, network hops, etc. The main portion of a packet contains the actual data being transfered. It is sometimes called the body or the payload.

Network Interface: A network interface can refer to any kind of software interface to networking hardware. For instance, if you have two network cards in your computer, you can control and configure each network interface associated

with them individually.A network interface may be associated with a physical device, or it may be a representation of a virtual interface. The "loopback" device, which is a virtual interface to the local machine, is an example of this.

LAN: LAN stands for "local area network". It refers to a network or a portion of a network that is not publicly accessible to the greater internet. A home or office network is an example of a LAN.

WAN: WAN stands for "wide area network". It means a network that is much more extensive than a LAN. While WAN is the relevant term to use to describe large, dispersed networks in general, it is usually meant to mean the internet, as a whole. If an interface is said to be connected to the WAN, it is generally assumed that it is reachable through the internet.

Protocol: A protocol is a set of rules and standards that basically define a language that devices can use to communicate. There are a great number of protocols in use extensively in networking, and they are often implemented in different layers. Some low level protocols are TCP, UDP, IP, and ICMP. Some familiar examples of application layer protocols, built on these lower protocols, are HTTP (for accessing web content), SSH, TLS/SSL, and FTP. Port: A port is an address on a single machine that can be tied to a specific piece of software. It is not a physical interface or location, but it allows your server to be able to communicate using more than one application.

Firewall: A firewall is a program that decides whether traffic coming into a server or going out should be allowed. A firewall usually works by creating rules for which type of traffic is acceptable on which ports. Generally, firewalls block ports that are not used by a specific application on a server.

NAT: NAT stands for network address translation. It is a way to translate requests that are incoming into a routing server to the relevant devices or servers that it knows about in the LAN. This is usually implemented in physical LANs as a way to route requests through one IP address to the necessary backend servers.

VPN: VPN stands for virtual private network. It is a means of connecting separate LANs through the internet, while maintaining privacy. This is used as a means of connecting remote systems as if they were on a local network, often for security reasons.

Interfaces: Interfaces are networking communication points for your computer. Each interface is associated with a physical or virtual networking device. Typically, your server will have one configurable network interface for each Ethernet or wireless internet card you have. In addition, it will define a virtual network interface called the "loopback" or localhost interface. This is used as an interface to connect applications and processes on a single computer to other applications and processes. You can see this referenced as the "lo" interface in many tools. Many times, administrators configure one interface to service traffic to the internet and another interface for a LAN or private network.

Protocols: Networking works by piggybacking a number of different protocols on top of each other. In this way, one piece of data can be transmitted using multiple protocols encapsulated within one another. We will talk about some of the more common protocols that you may come across and attempt to explain the difference, as well as give context as to what part of the process they are involved with. We will start with protocols implemented on the lower networking layers and work our way up to protocols with higher abstraction.

Exercises:

4.1. Enumerating interfaces on your machine

Code:

```
import sys

import socket

import fcntl

import struct

import array

SIOCGIFCONF = 0x8912 #from C library sockios.h

STUCT_SIZE_32 = 32

STUCT_SIZE_64 = 40

PLATFORM_32_MAX_NUMBER = 2**32

DEFAULT_INTERFACES = 8

def list_interfaces():

interfaces = []

max_interfaces = DEFAULT_INTERFACES

is_64bits = sys.maxsize > PLATFORM_32_MAX_NUMBER

struct_size = STUCT_SIZE_64 if is_64bits else STUCT_SIZE_32

sock = socket.socket(socket.AF_INET, socket.SOCK_DGRAM)

while True:
```

```python
bytes = max_interfaces * struct_size

interface_names = array.array('B', '\0' * bytes)

sock_info = fcntl.ioctl(

sock.fileno(),

SIOCGIFCONF, struct.pack('iL', bytes,interface_names.buffer_info()[0]) )

outbytes = struct.unpack('iL', sock_info)[0]

if outbytes == bytes: max_interfaces *= 2 else:

break namestr = interface_names.tostring()

for i in range(0, outbytes, struct_size):

interfaces.append((namestr[i:i+16].split('\0', 1)[0]))

return interfaces

if __name__ == '__main__':

interfaces = list_interfaces()

print( "This machine has %s network interfaces:

%s." %(len(interfaces), interface))
```

Output:

```
/home/meraz/PycharmProjects/pythonProject/venv/bin/python /home/meraz/PycharmProjects/pythonProject/Hello.py
This machine has 2 network interfaces:['lo','etho']
```

Exercise 4.2: Finding the IP address for a specific interface on your machine

Code:

```python
import argparse
```

```python
import sys

import socket

import fcntl

import struct

import array

def get_ip_address(ifname):

s = socket.socket(socket.AF_INET, socket.SOCK_DGRAM)

return socket.inet_ntoa(fcntl.ioctl(

s.fileno()

, 0x8915, # SIOCGIFADDR

struct.pack('256s', ifname[:15])

)[20:24])

if __name__ == '__main__':

#interfaces = list_interfaces()

parser = argparse.ArgumentParser(description='Python networking utils')

parser.add_argument('--ifname', action="store", dest="ifname",

required=True)

given_args = parser.parse_args()

ifname = given_args.ifname

print ("Interface [%s] --> IP: %s" %(ifname, get_ip_ address(ifname)))
```

Output:

```
/home/meraz/PycharmProjects/pythonProject/venv/bin/python /home/meraz/
Interface[eth0]-->IP:10.0.2.15
```

Exercise 4.3: Finding whether an interface is up on your machine

Code:

```python
import argparse

import socket

import struct

import fcntl

import nmap

SAMPLE_PORTS = '21-23'

def get_interface_status(ifname):

sock = socket.socket(socket.AF_INET, socket.SOCK_DGRAM)

ip_address = socket.inet_ntoa(fcntl.ioctl

( sock.fileno(),

0x8915, #SIOCGIFADDR, C socket library sockios.h

struct.pack('256s', ifname[:15]))[20:24])

nm = nmap.PortScanner()

nm.scan(ip_address, SAMPLE_PORTS)
```

return nm[ip_address].state()

if __name__ == '__main__':

parser = argparse.ArgumentParser(description='Python networking utils')

parser.add_argument('--ifname', action="store", dest="ifname", required=True)

given_args = parser.parse_args() ifname = given_args.ifname

print ("Interface [%s] is: %s" %(ifname, get_interface_ status(ifname)))

output:

```
/home/meraz/PycharmProjects/pythonProject/venv/bin/python
Interface[eth0 is:up
```

Exercise 4.8: Sniffing packets on your network

Code:

```
meraz@meraz-virtualbox:~$ tcpdump -help
tcpdump version 4.9.3
libpcap version 1.8.1
OpenSSL 1.1.1  11 Sep 2018
Usage: tcpdump [-aAbdDefhHIJKlLnNOpqStuUvxX#] [ -B size ] [ -c count ]
               [ -C file_size ] [ -E algo:secret ] [ -F file ] [ -G seconds ]
               [ -i interface ] [ -j tstamptype ] [ -M secret ] [ --number ]
               [ -Q in|out|inout ]
               [ -r file ] [ -s snaplen ] [ --time-stamp-precision precision ]
               [ --immediate-mode ] [ -T type ] [ --version ] [ -V file ]
               [ -w file ] [ -W filecount ] [ -y datalinktype ] [ -z postrotate
-command ]
               [ -Z user ] [ expression ]
```

Conclusion:

There are two levels of network service access in Python. These are:

Low-Level Access

High-Level Access

In the first case, programmers can use and access the basic socket support for the operating system using Python's libraries, and programmers can implement both connection-less and connection-oriented protocols for programming. Application-level network protocols can also be accessed using high-level access provided by Python libraries. These protocols are HTTP, FTP, etc. A socket is the end-point in a flow of communication between two programs or communication channels operating over a network. They are created using a set of programming requests called socket API (Application Programming Interface). Python's socket library offers classes for handling common transports as a generic interface. Sockets use protocols for determining the connection type for port-to-port communication between client and server machines. The protocols are used for:

Domain Name Servers (DNS)

IP addressing

E-mail

FTP (File Transfer Protocol) etc...

Python has a socket method that let programmers' set-up different types of socket virtually. After you defined the socket, you can use several methods to manage the connections. Some of the important server socket methods are:

listen(): is used to establish and start TCP listener.

bind(): is used to bind-address (host-name, port number) to the socket.

accept(): is used to TCP client connection until the connection arrives.

connect(): is used to initiate TCP server connection.

send(): is used to send TCP messages.

recv(): is used to receive TCP messages.

sendto(): is used to send UDP messages

close(): is used to close a socket.

Sending messages back and forth using different basic protocols is simple and straightforward. It shows that programming takes a significant role n client-server architecture where the client makes data request to a server, and the server replies to those machines.