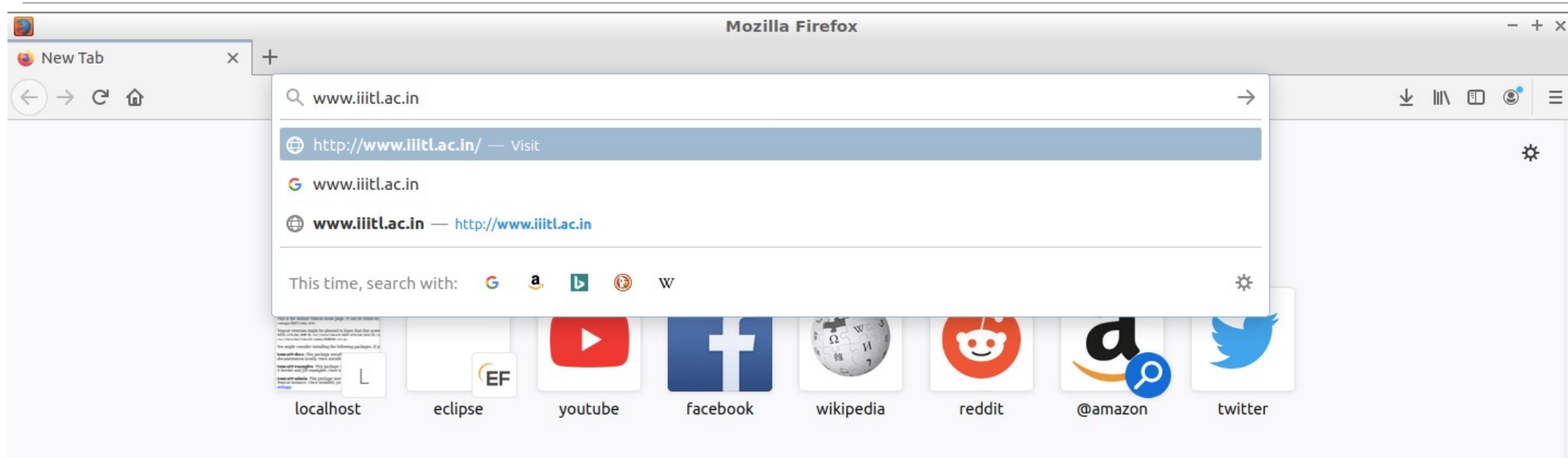


Object Oriented Methodology

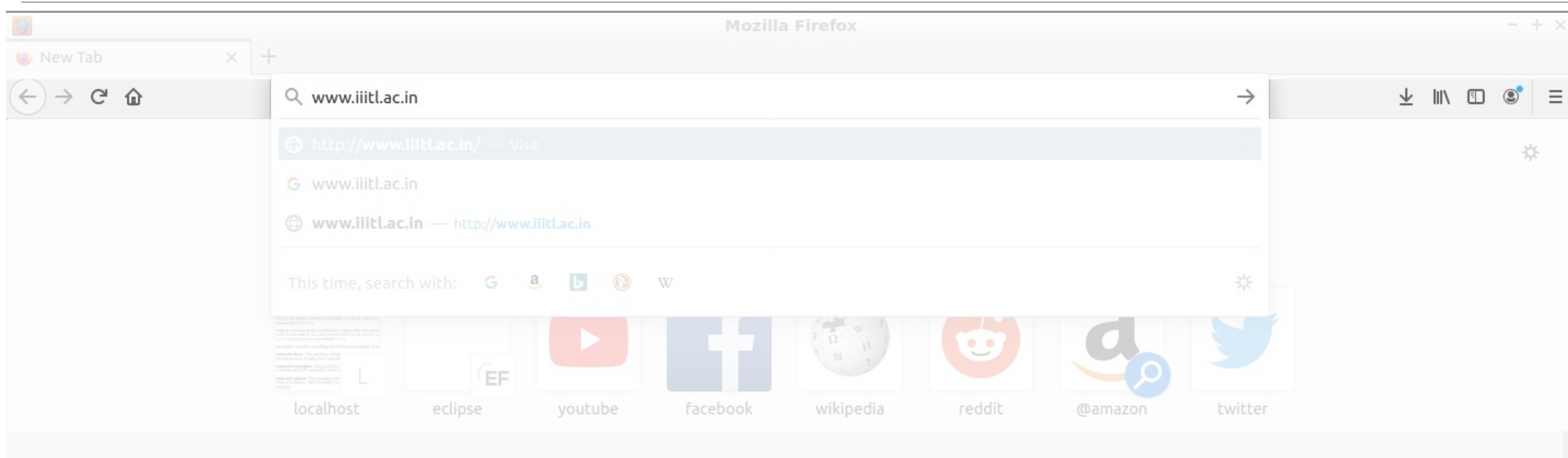
Week – 8, Lecture – 2
Networking Basics

SAURABH SRIVASTAVA
VISITING FACULTY
IIIT LUCKNOW

What happens when you open a webpage?

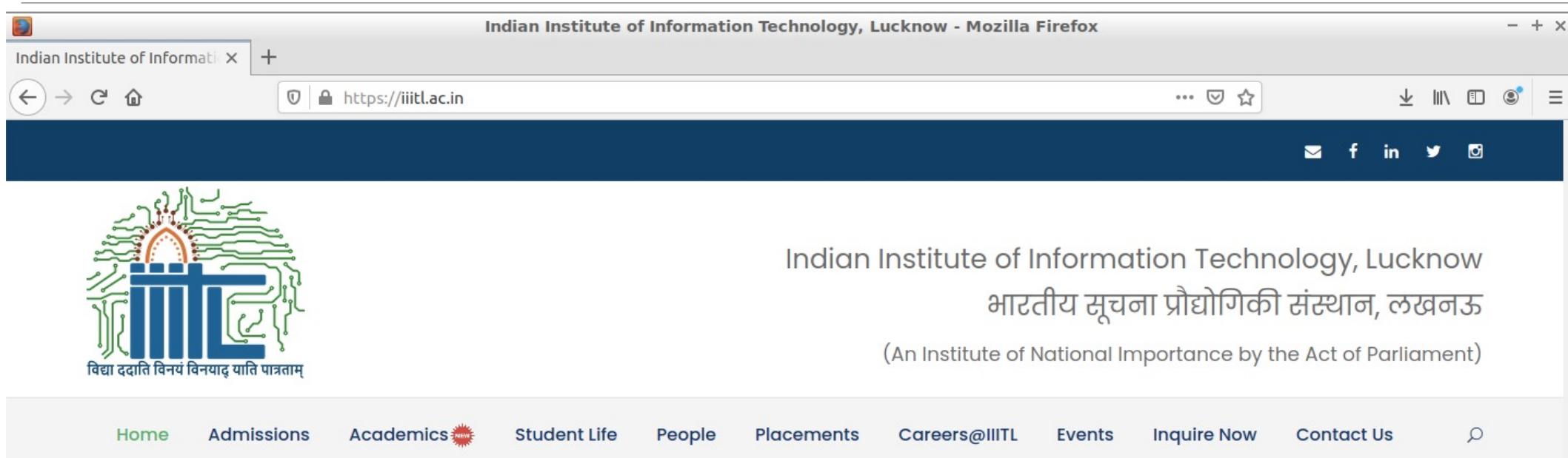


What happens when you open a webpage?



You type the address of the page in the Address Bar of the browser and press Enter

What happens when you open a webpage?



... and the page loads !!

What happens when you open a webpage?

However, the world of networks do not know what is “`www.iiitl.ac.in`”

- For that matter, it doesn't know what is “`www.google.com`” either !!

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- To be precise they work on bits, but then, everything related to Computer Science can be taken there !!

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Two most common set of “numbers” that networks use are *IP Addresses* and *Port Numbers*

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Two most common set of “numbers” that networks use are *IP Addresses* and *Port Numbers*

IP Addresses are *unique* identifiers for members, *within a network*

- The network could be managed by a private entity, often called an *intranet*
- Or it could be a large, world-wide network, that we all know as the *Internet*

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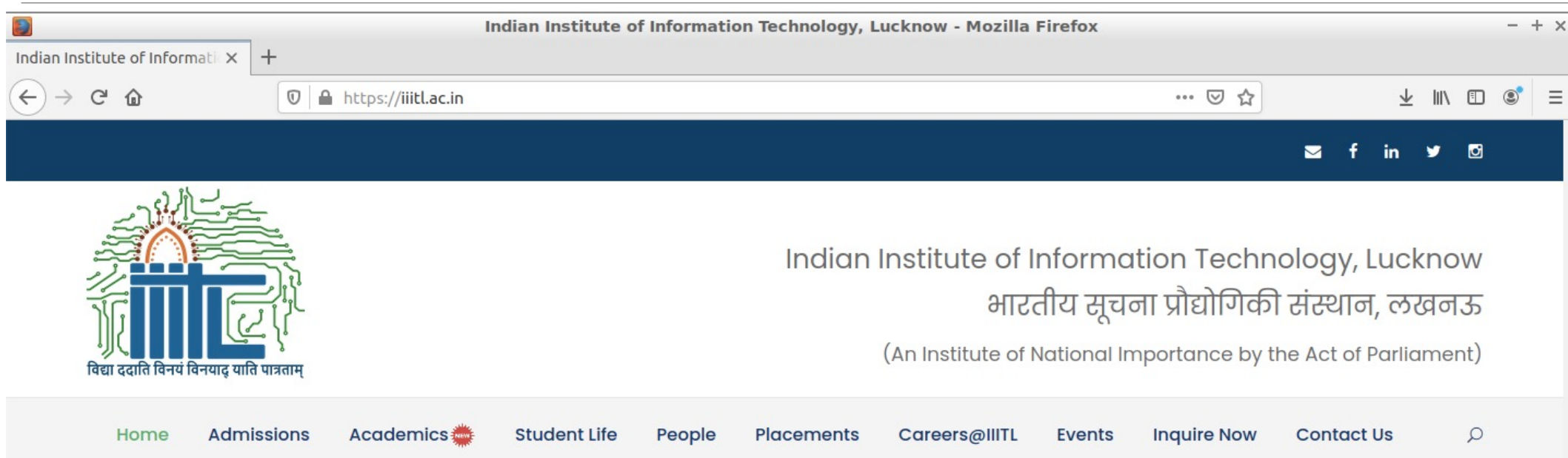
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Port Numbers (along with the IP Address), can be seen as a particular communication channel

- A particular member can communicate simultaneously over different communication channels

What happens when you open a webpage?



So where are the IP Addresses and Port Numbers here?

What happens when you open a webpage?

```
saurabh@saurabh-VirtualBox:~$ ping www.iiitl.ac.in
PING iiitl.ac.in (162.241.148.182) 56(84) bytes of data.
64 bytes from bh-ht-18.webhostbox.net (162.241.148.182): icmp_seq=1 ttl=41 time=282 ms
64 bytes from bh-ht-18.webhostbox.net (162.241.148.182): icmp_seq=2 ttl=41 time=402 ms
64 bytes from bh-ht-18.webhostbox.net (162.241.148.182): icmp_seq=3 ttl=41 time=321 ms
64 bytes from bh-ht-18.webhostbox.net (162.241.148.182): icmp_seq=4 ttl=41 time=523 ms
64 bytes from bh-ht-18.webhostbox.net (162.241.148.182): icmp_seq=5 ttl=41 time=341 ms
64 bytes from bh-ht-18.webhostbox.net (162.241.148.182): icmp_seq=6 ttl=41 time=358 ms
64 bytes from bh-ht-18.webhostbox.net (162.241.148.182): icmp_seq=7 ttl=41 time=283 ms
^C
--- iiitl.ac.in ping statistics ---
7 packets transmitted, 7 received, 0% packet loss, time 6048ms
rtt min/avg/max/mdev = 282.105/358.912/523.268/77.624 ms
saurabh@saurabh-VirtualBox:~$
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The ping command should give you something that looks like an IP Address

An IP Address is a combination of 4 integers, separated by dots

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```

This description of an IP Address is *wildly inaccurate*, but it suffices our purpose

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An IP Address is a combination of 4 integers, separated by dots

What happens when you open a webpage?

While `ping` will also tell you the IP Address of a website, that is not its function

- It is used to check if a “particular member” of the network is “alive or not”

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The command that gives you more information in this regard is `dig`

- The `dig` command can show you the IP Address for a “lookup String”
- This String is usually a domain, such as `google.com` or `iiitl.ac.in`
- The `dig` command shows much more information (that you don’t probably need to know right now)

What happens when you open a webpage?

```
saurabh@saurabh-VirtualBox:~$ dig www.iiitl.ac.in

; <>> DiG 9.11.3-1ubuntu1.13-Ubuntu <>> www.iiitl.ac.in
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 29172
;; flags: qr rd ra; QUERY: 1, ANSWER: 2, AUTHORITY: 0, ADDITIONAL: 1

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags;; udp: 65494
;; QUESTION SECTION:
;www.iiitl.ac.in.                IN      A

;; ANSWER SECTION:
www.iiitl.ac.in.                6971    IN      CNAME   iiitl.ac.in.
iiitl.ac.in.                    4794    IN      A       162.241.148.182

;; Query time: 0 msec
;; SERVER: 127.0.0.53#53(127.0.0.53)
;; WHEN: Sun Nov 22 11:15:40 IST 2020
;; MSG SIZE rcvd: 74

saurabh@saurabh-VirtualBox:~$
```

What happens when you open a webpage?

```
saurabh@saurabh-VirtualBox:~$ dig www.iiitl.ac.in

; <>> DiG 9.11.3-lubuntu1.13-Ubuntu <>> www.iiitl.ac.in
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 29172
;; flags: qr rd ra; QUERY: 1, ANSWER: 2, AUTHORITY: 0, ADDITIONAL: 1

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That's all you need to know as of now !!

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```

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The CNAME entry shows that `iiitl.ac.in` is an alias for `www.iiitl.ac.in`

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What about the IP Address of the “other communicating member” on network, i.e., your machine?

- The `ip` command with the “a” switch can tell you that

What happens when you open a webpage?

```
saurabh@saurabh-VirtualBox:~$ ip a
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
        valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
        valid_lft forever preferred_lft forever
2: enp0s3: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel state UP group default qlen
1000
    link/ether 08:00:27:34:b0:e6 brd ff:ff:ff:ff:ff:ff
    inet 192.168.0.100/24 brd 192.168.0.255 scope global dynamic noprefixroute enp0s3
        valid_lft 86183sec preferred_lft 86183sec
    inet6 fe80::5ff4:a36b:6804:b324/64 scope link noprefixroute
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    link/ether 08:00:27:34:b0:e6 brd ff:ff:ff:ff:ff:ff
    inet 192.168.0.100/24 brd 192.168.0.255 scope global dynamic noprefixroute enp0s3
        valid_lft 86183sec preferred_lft 86183sec
    inet6 fe80::5ff4:a36b:6804:b324/64 scope link noprefixroute
        valid_lft forever preferred_lft forever
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```

That's where you see the
IP Address

What happens when you open a webpage?

What about the Port Number?

- That doesn't require a tool – the website uses Port Number 443 for communication
- It is *implied* here, i.e., the browser figures it out when it sees “https” in the address

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443 is a *well-known* Port Number

- It is used for communication over the Hypertext Transfer Protocol Secure or HTTPS
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A website that communicates over HTTP instead of HTTPS uses Port Number 80 instead

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On your machine, there may be more Port Numbers being used for communication

- You usually do not need to know this – they are allotted automatically
- You can use the `netstat -ntp` command if you are interested in knowing them anyway

What happens when you open a webpage?

```
saurabh@saurabh-VirtualBox:~$ netstat -ntp | grep -i 162.241.148.182
(Not all processes could be identified, non-owned process info
 will not be shown, you would have to be root to see it all.)
tcp        0      0 192.168.0.100:48254    162.241.148.182:443    ESTABLISHED 1393/firefox
tcp        0      0 192.168.0.100:48256    162.241.148.182:443    TIME_WAIT   -
saurabh@saurabh-VirtualBox:~$
```

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tcp        0      0 192.168.0.100:48256    162.241.148.182:443    TIME_WAIT   -
saurabh@saurabh-VirtualBox:~$
```

The grep command filters the entries for the `iiitl` page only

The OSI Reference Model

A lot goes on in the background when two machines communicate over a network

- We just talked about some addresses and ports that work in the background

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The overall process involves multiple *layers* of processing

- The layer where you supplied the name of the website is at the top
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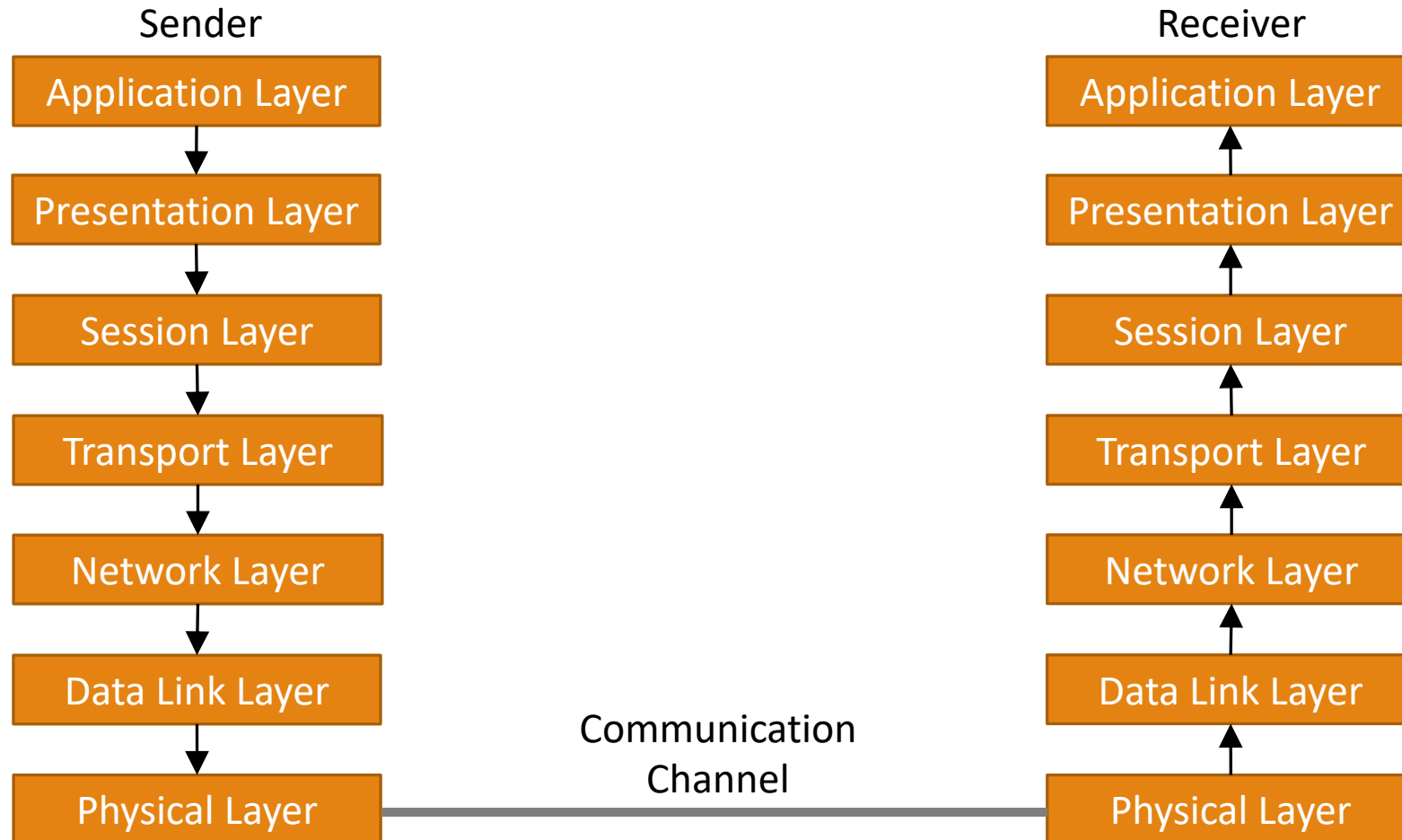
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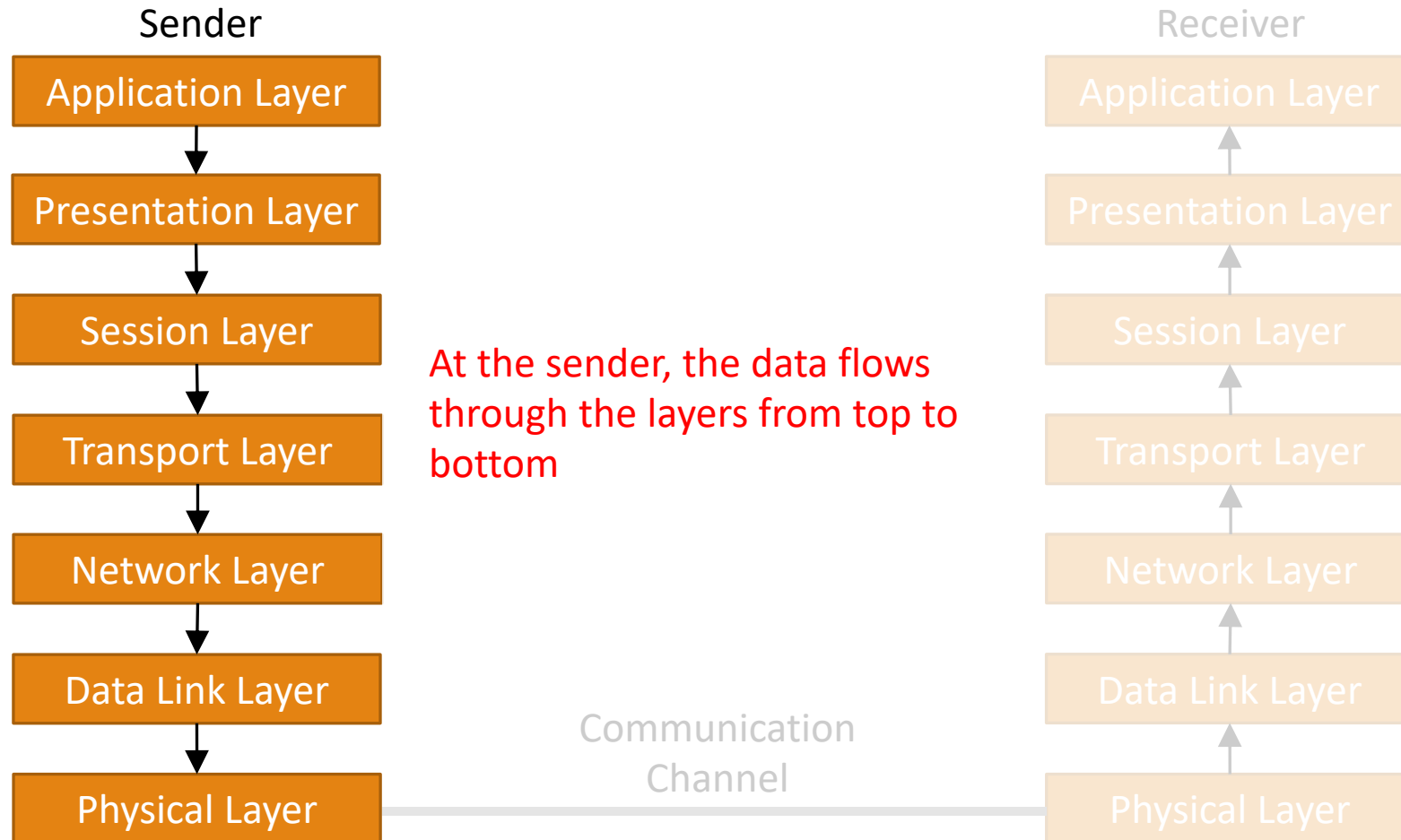
Different layers add or remove some information from the data

- The data is usually meant for the layer's peer – on the other side of the communication

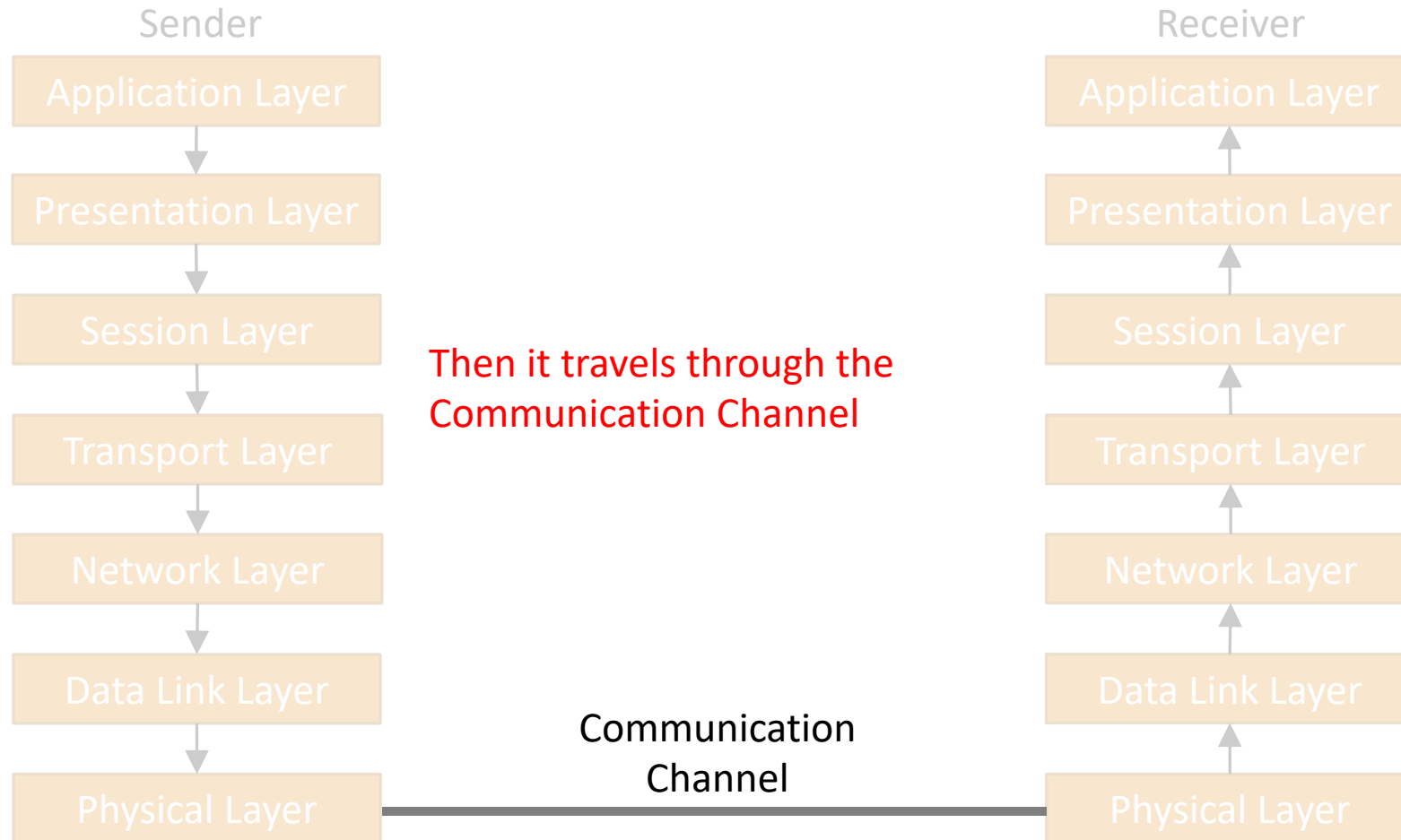
The OSI Reference Model



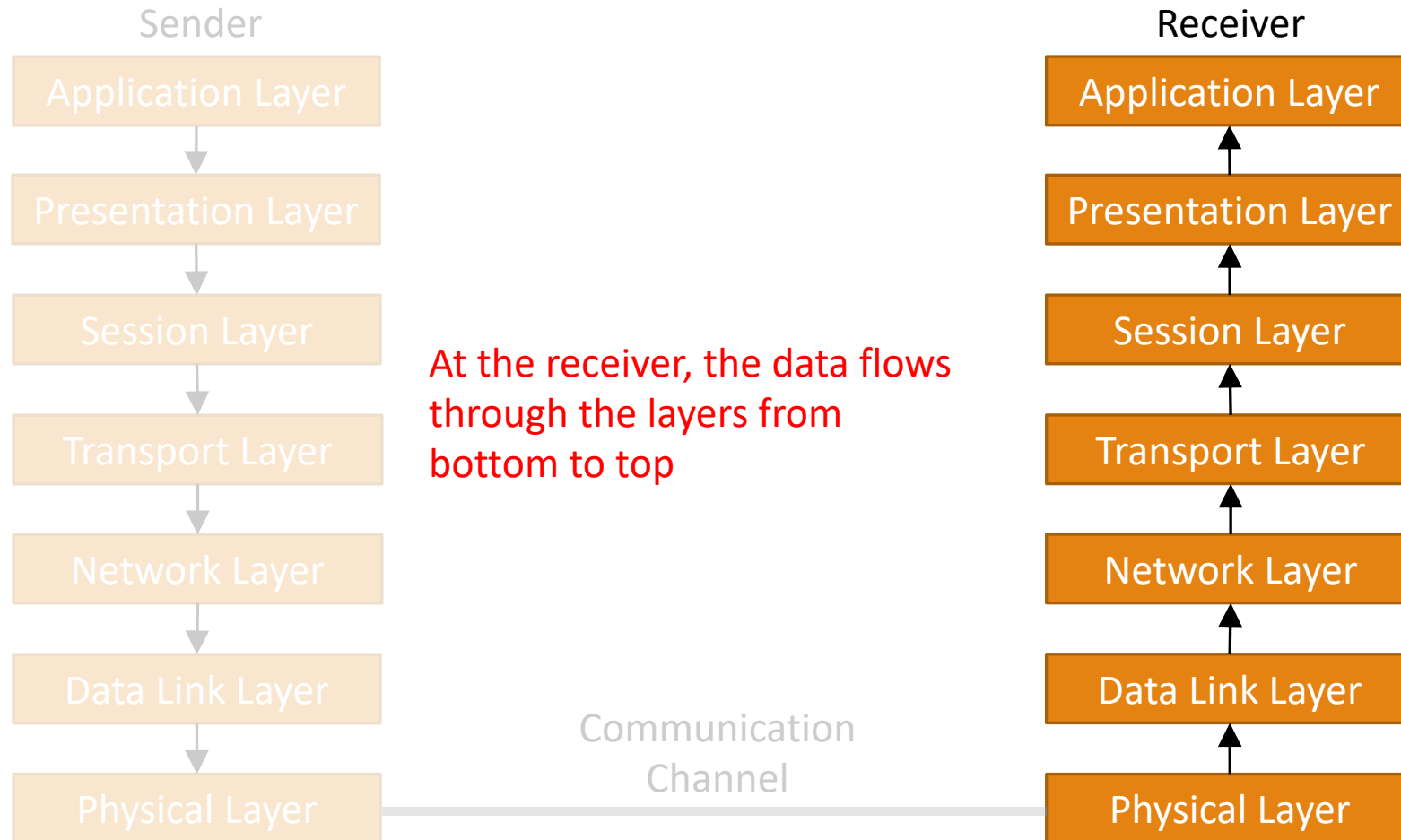
The OSI Reference Model



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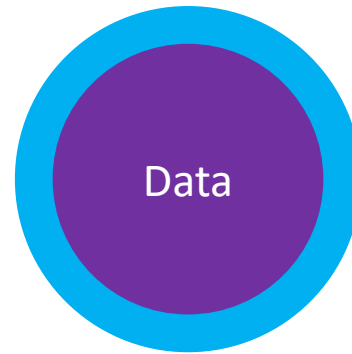
The OSI Reference Model



Data at Layer 7

At the sender

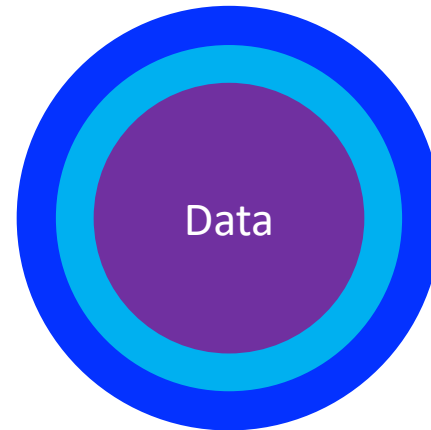
The OSI Reference Model



Data at Layer 6

At the sender

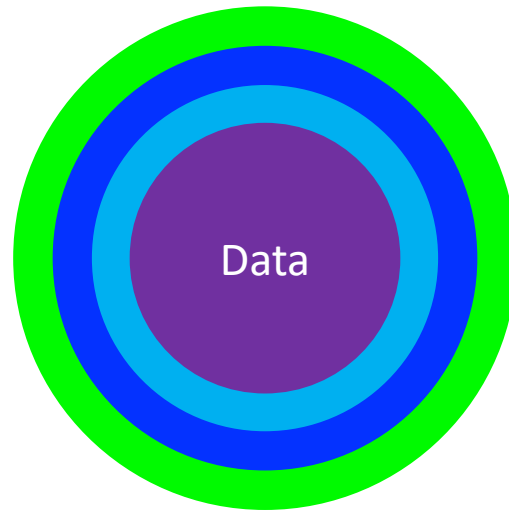
The OSI Reference Model



Data at Layer 5

At the sender

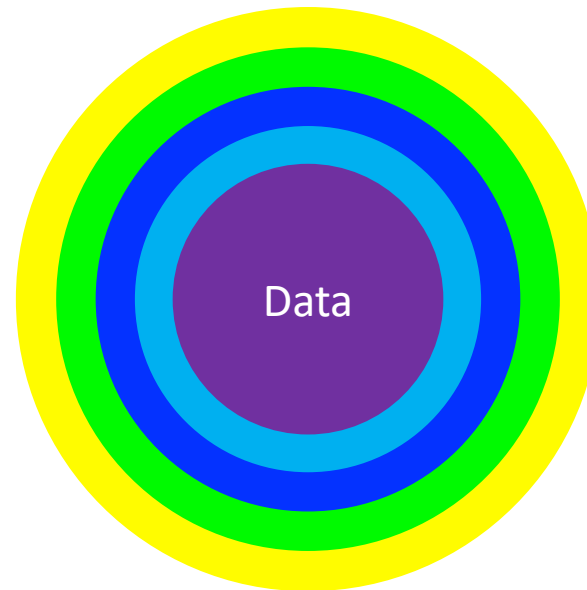
The OSI Reference Model



Data at Layer 4

At the sender

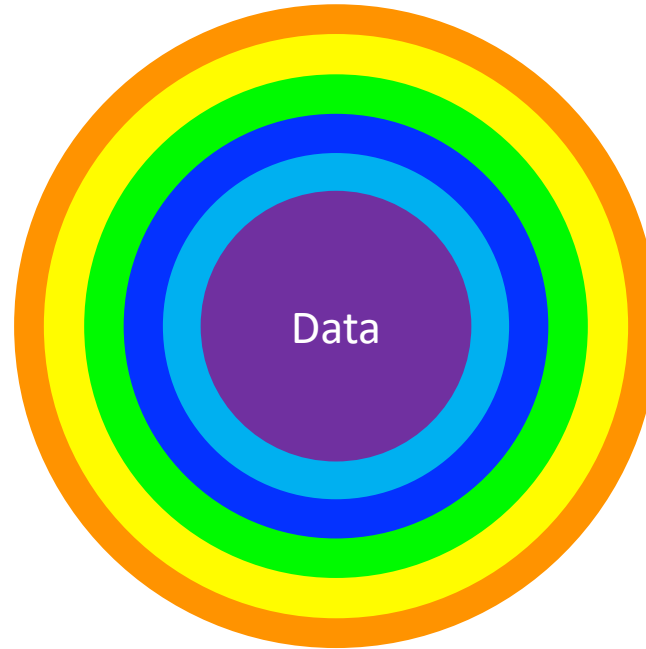
The OSI Reference Model



Data at Layer 3

At the sender

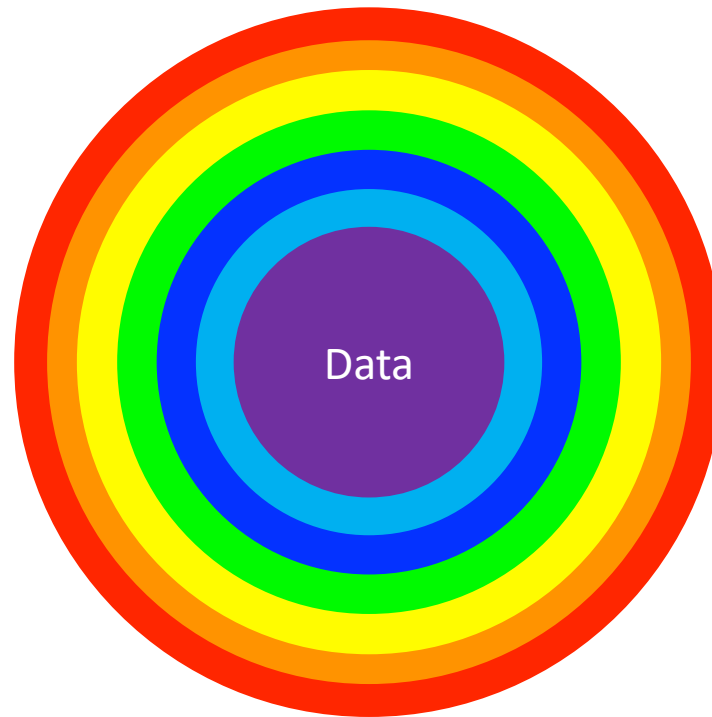
The OSI Reference Model



Data at Layer 2

At the sender

The OSI Reference Model



Data at Layer 1

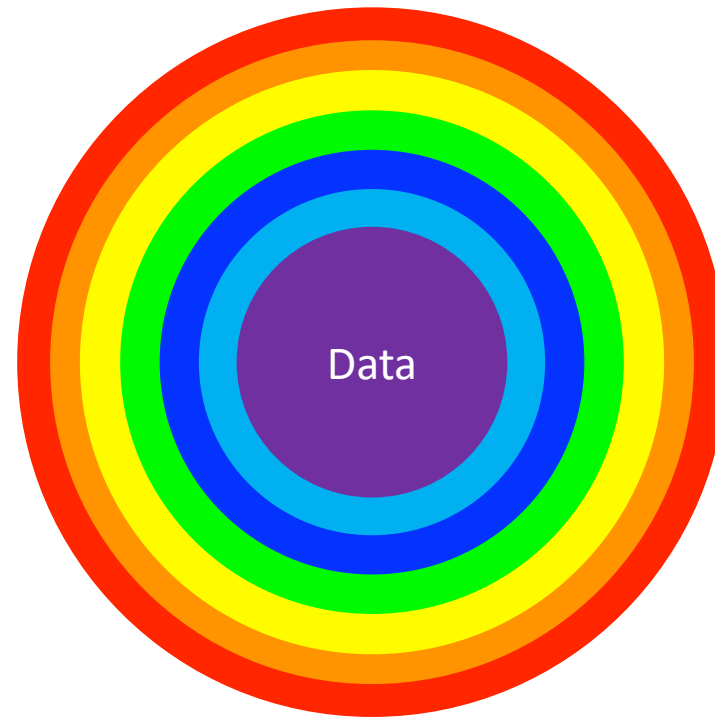
At the sender

The OSI Reference Model



Data Sent over the
Communication
Channel

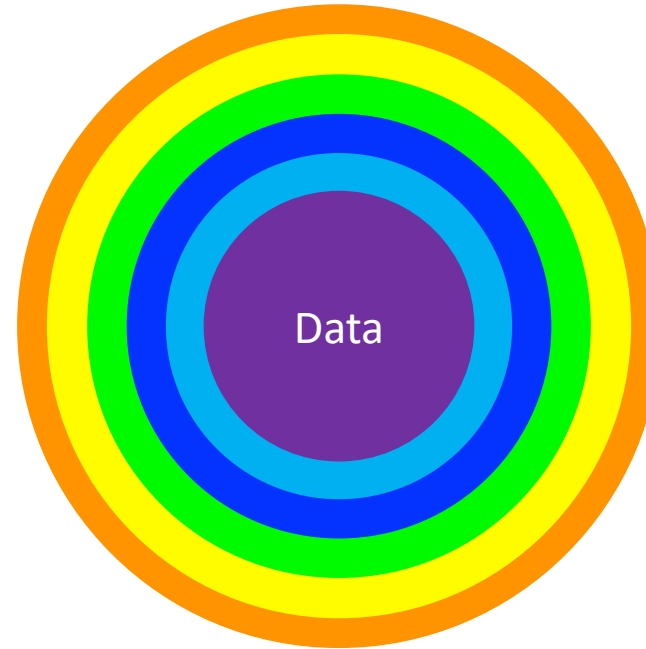
The OSI Reference Model



Data at Layer 1

At the receiver

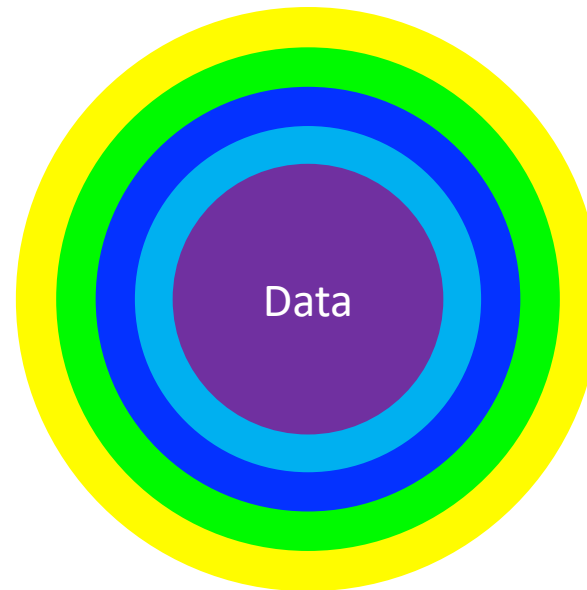
The OSI Reference Model



Data at Layer 2

At the receiver

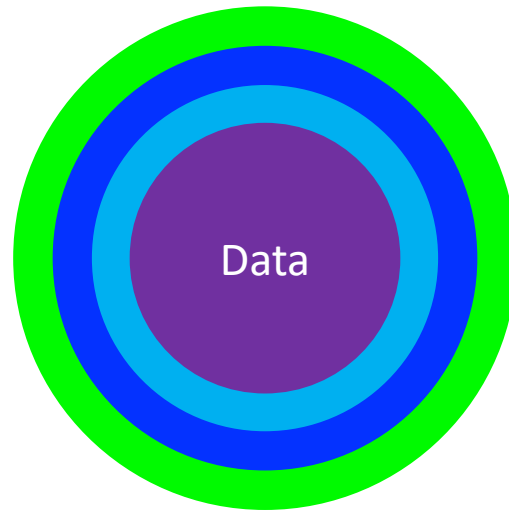
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Data at Layer 3

At the receiver

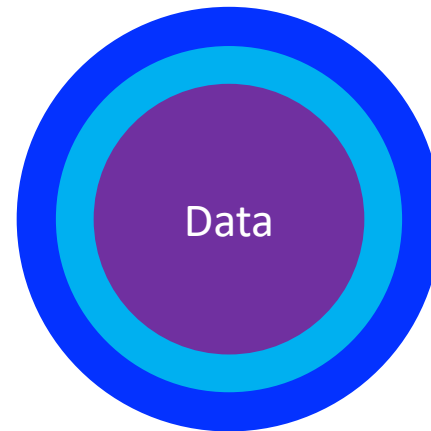
The OSI Reference Model



Data at Layer 4

At the receiver

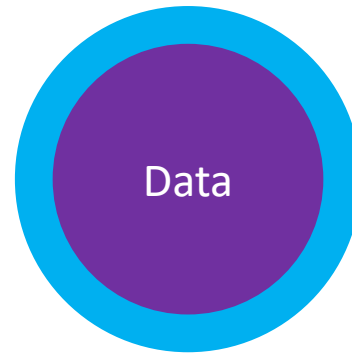
The OSI Reference Model



Data at Layer 5

At the receiver

The OSI Reference Model



Data at Layer 6

At the receiver

The OSI Reference Model



Data at Layer 7

At the receiver

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The OSI Reference Model is a conceptual model, which divides the process in seven layers

- Each layer receives some data, processes it in some way, and passes it to the next layer

Different layers add or remove some information from the data

- The data is usually meant for the layer's peer – on the other side of the communication

You don't need to know about all the layers as of now, except for two layers

- Just know that different layers use different mechanisms or *protocols* to add or remove additional information

The Network and Transport Layers

The Transport Layer (layer 4) manages end-to-end connection between the sender and the receiver

- To do so, it uses the IP Addresses and the Port Numbers that we discussed earlier
- It makes sure that all the data sent from the sender reaches the receiver, and its order is maintained as well
- **This is actually not true in all cases, but for us, it is !! (see the Additional Reading Section)**

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With IP Addresses and the relevant Port Numbers, two members of the network can communicate

- That is all you need for now !!

Homework !!

Try out the `ip`, `dig` and `netstat` commands

- This could be your first steps towards the vast arena of Networking, motivating you to learn more

If you are using a VM, see if you can ping the IP address of your host machine

- Try the same from the host as well ...
- ... if you do not succeed, it is fine :D

Additional Reading

Read more about User Datagram Protocol or UDP

- Figure out how it is different from TCP
- This link may be helpful:
<https://www.geeksforgeeks.org/differences-between-tcp-and-udp/>

If you could not ping your VM from your host machine, you may be tempted to read this article

- <https://www.virtualbox.org/manual/ch06.html#networkingmodes>