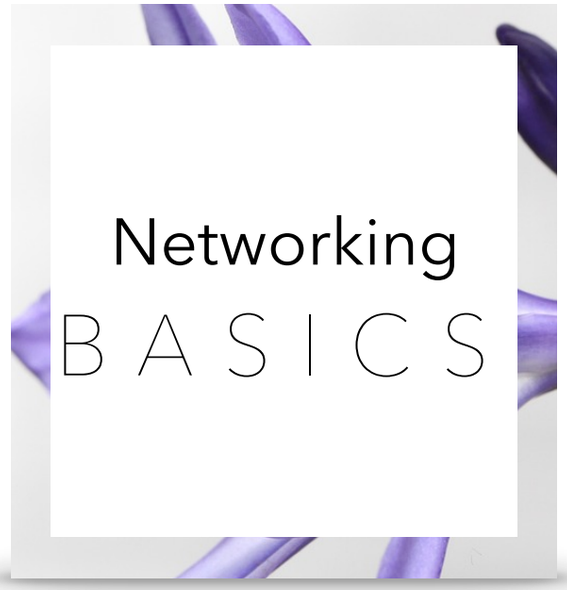

50.005 CSE

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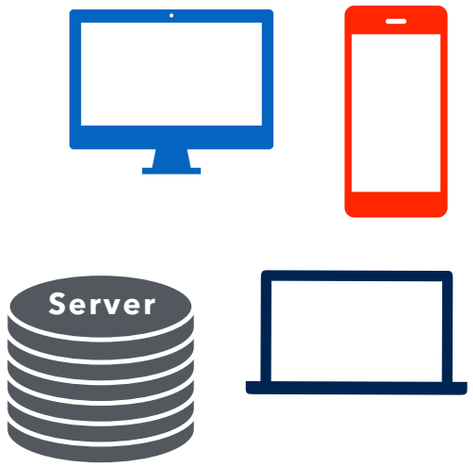
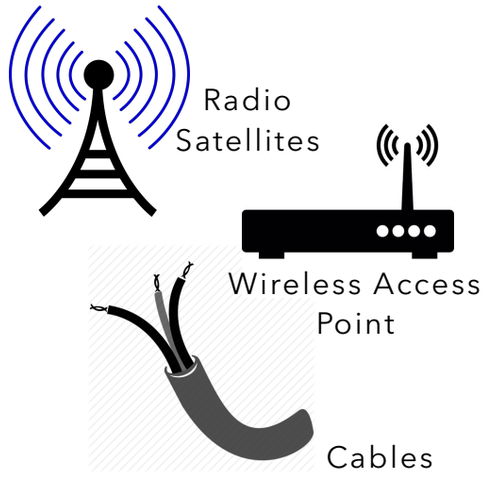
Information Systems Technology and Design
SUTD

WHAT MAKES THE INTERNET?

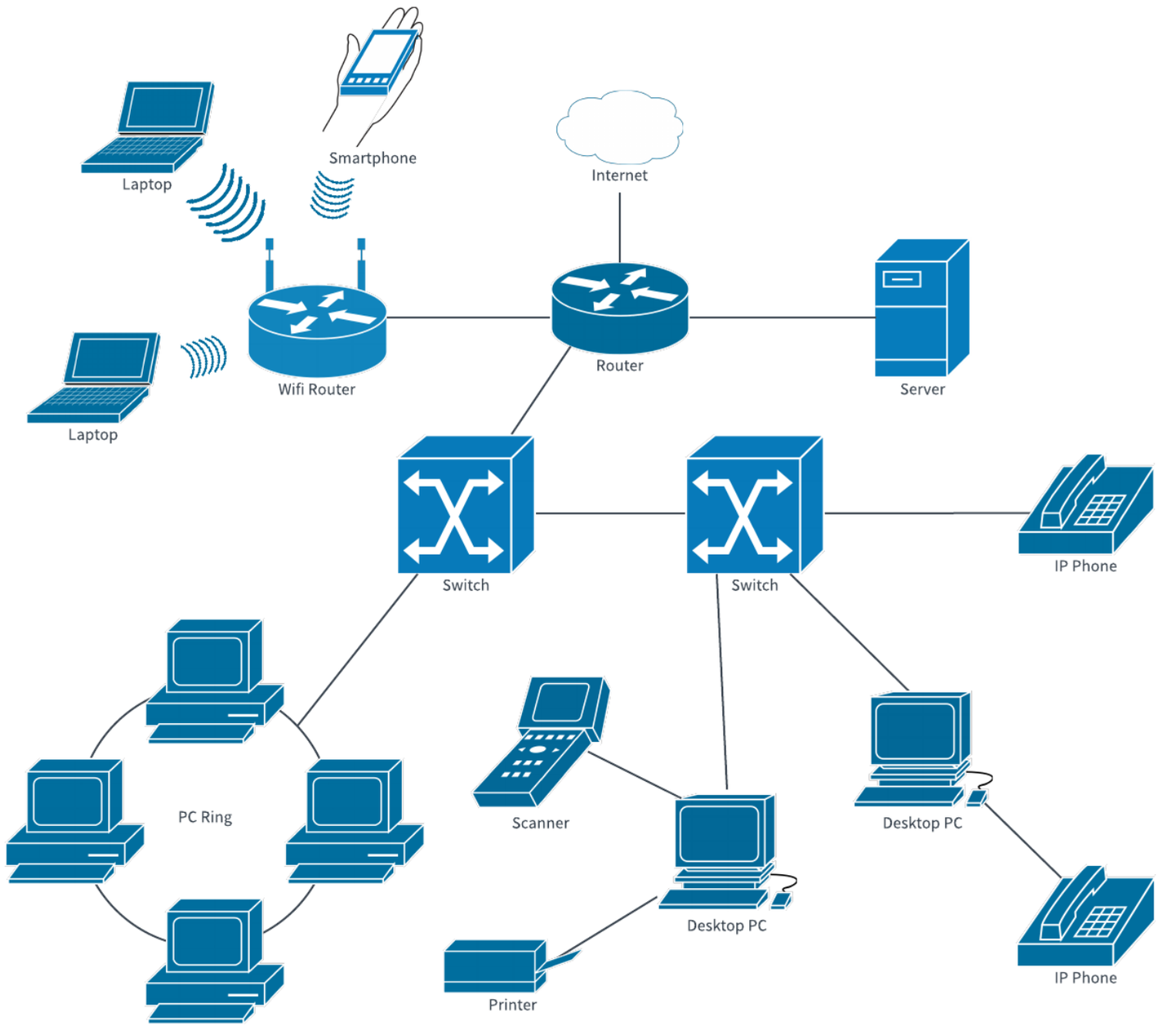


Hosts
Running network apps



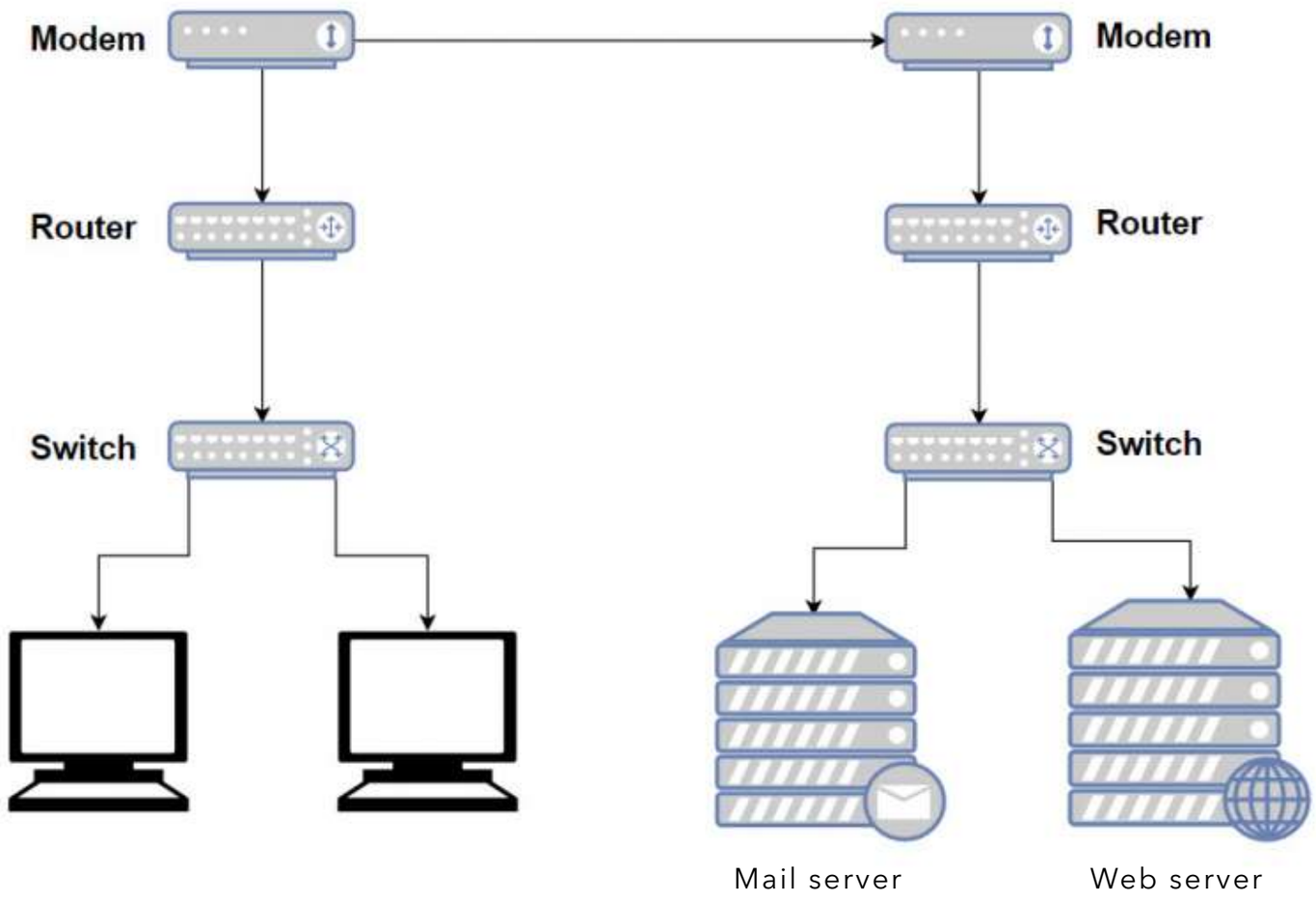
Communication Links
Running network apps

Packet Switches
Forward chunks of data
called “packets”

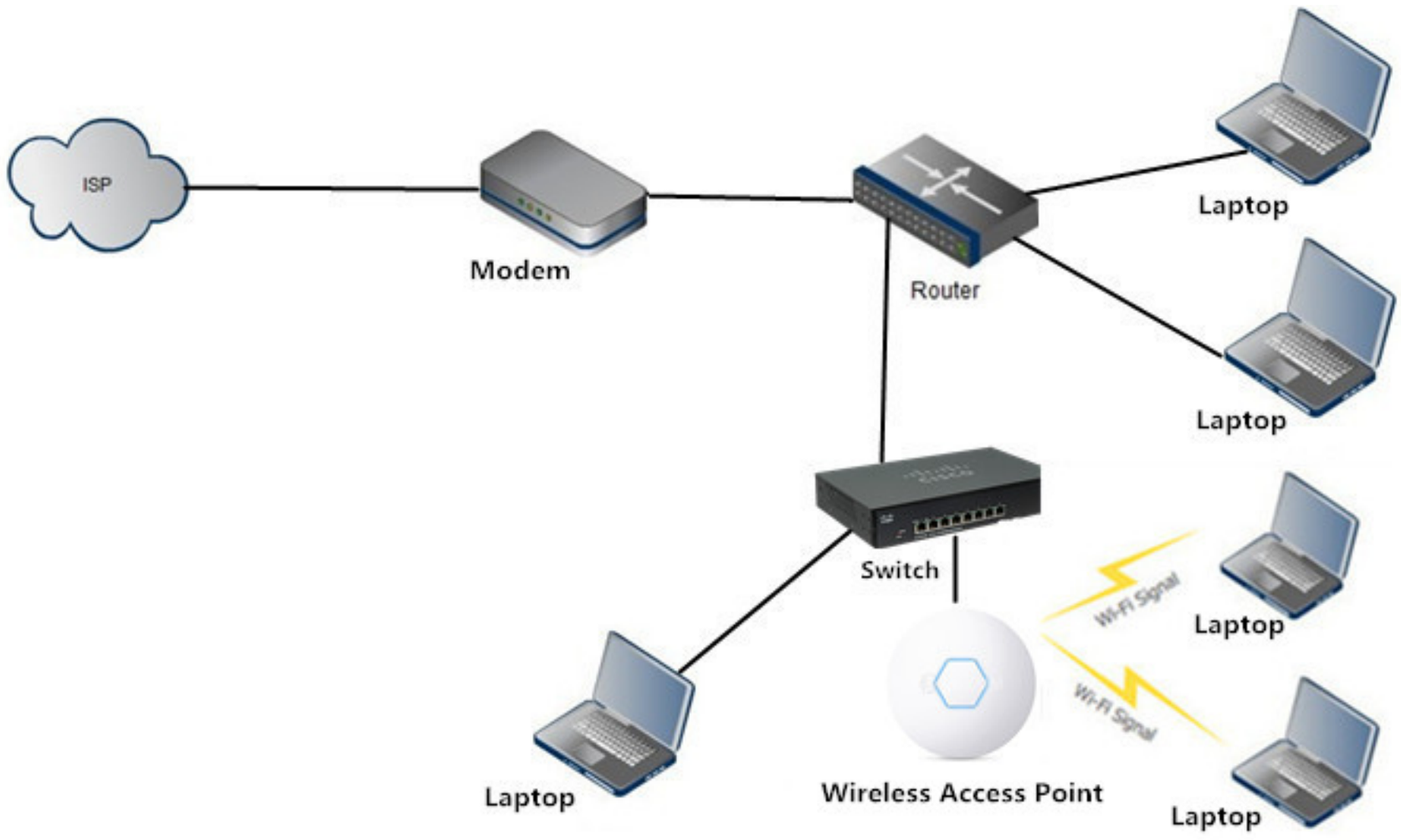


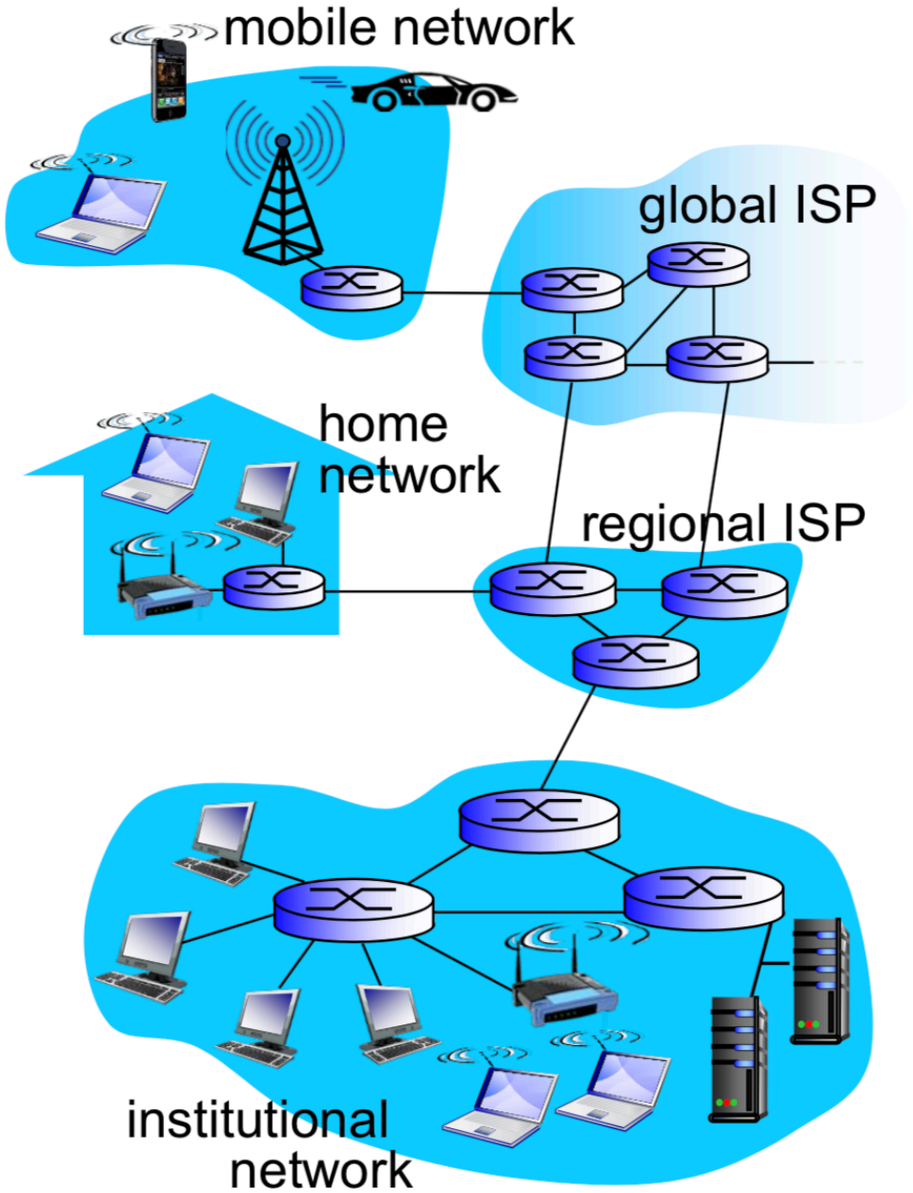
CONNECTING THEM TOGETHER

MODEM? ROUTER? SWITCHES?



YES, THAT WIRELESS ACCESS POINT...





General View of the Internet

ISP : Internet Service Provider

What does it do?
An organization that provides services for accessing and using the internet.

Example in Singapore
(regional ISP): M1, Starhub, Singtel, etc

Tier 1 network (global ISP): AT&T, Sprint, Verizon, Tata Comms, etc

You need several things to connect a bunch of networks together to form the internet:

1. Internet standards that specifies **protocols**

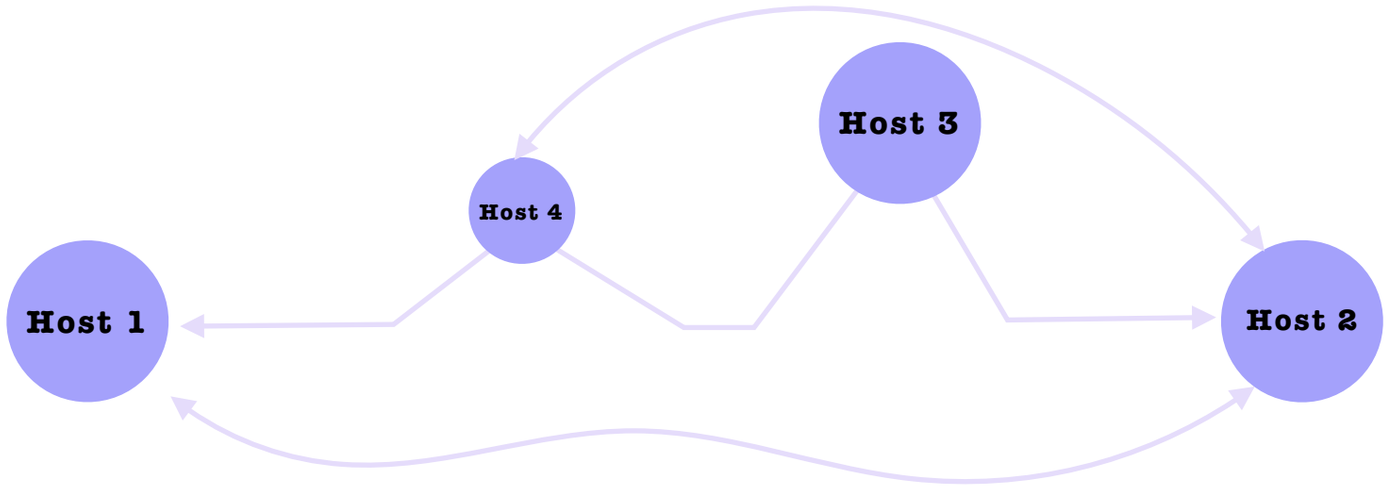
2. Infrastructures that provide services to user applications using **network API**

3. Infrastructures that allow **sharing** among many

4. A mechanism that supports **complex** interacting components

5. It also has to be **scalable**

1. PROTOCOL



Defines the set of rules: **format & order** on how to **send messages** through the internet

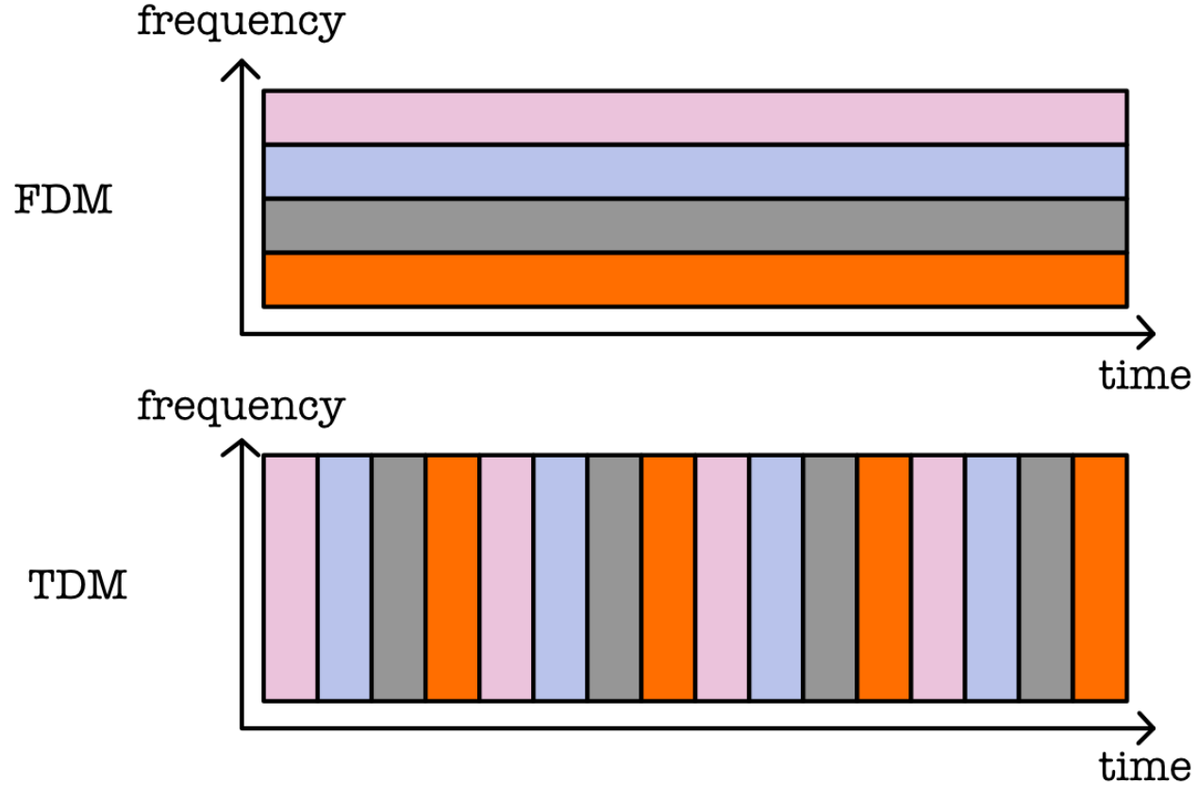
Who sets it?

The **IETF** (Internet Engineering Task Force) publishes formal documents called **RFC** (Request for Comment) that contains protocols

2. SHARING: **CIRCUIT SWITCHING**

A fixed, **dedicated** fraction of the link for each user. Good for continuous, streamline usage.

Method 1 : Time Domain Multiplexing (**TDM**)
Method 2 : Frequency Domain Multiplexing (**FDM**)



2. SHARING: **PACKET SWITCHING**

Packets occupy link **on demand**. Better for **bursty data.**

Good for this type of scenario:
- 1 Mbps link, shared among 10 users
- Users will use 100Kb/s if they're active
- *but* active only 10% of the time

What is the probability that all of them are active at the same time?

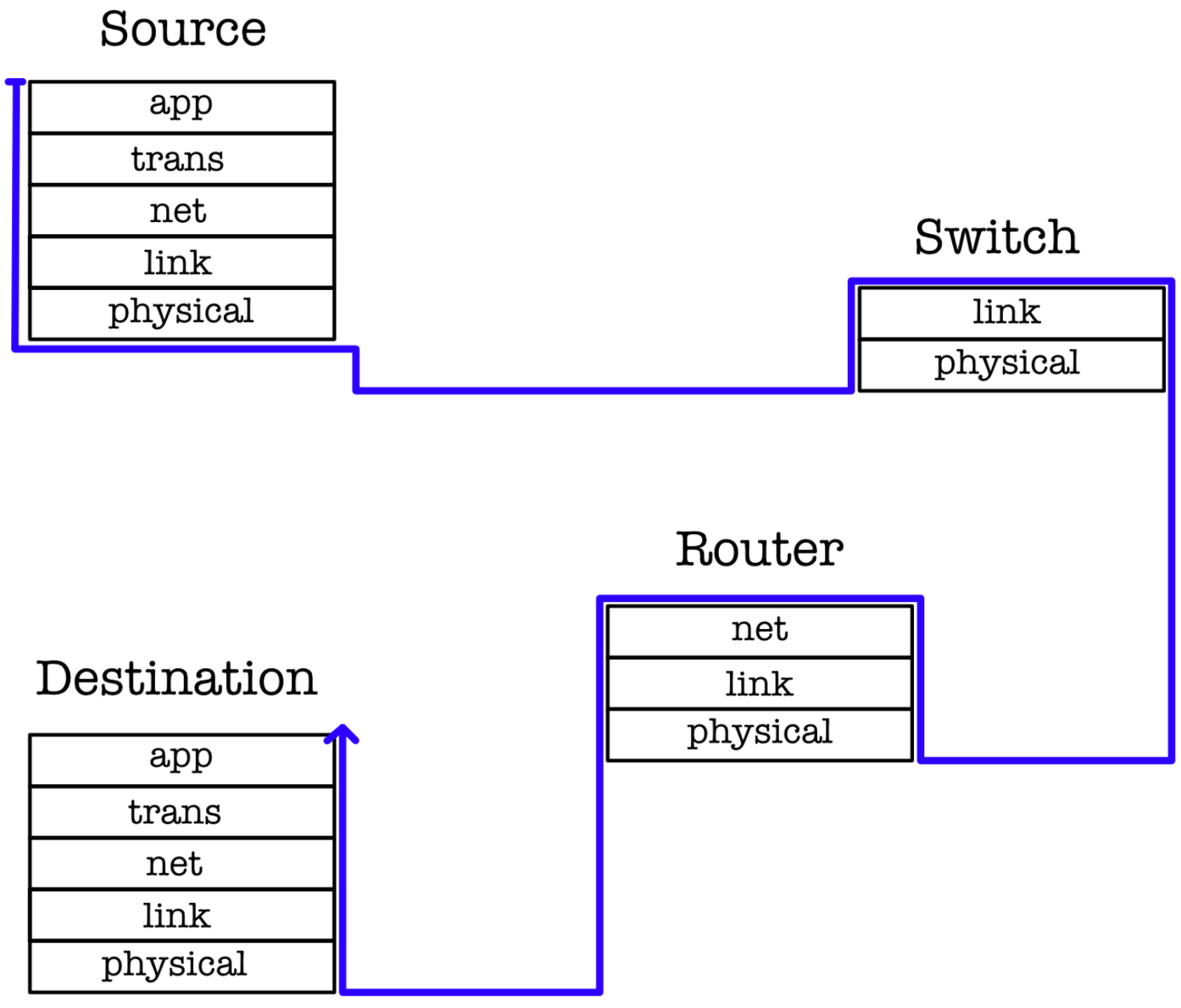
$$P_{active=k} = \binom{N}{k} P_a^k \, 0.9^{N-k}$$

$$P_{active=10} = \binom{10}{10} 0.1^{10} \, 0.9^{10-10} = 0.1^{10}$$

3. LAYERING

The **internet protocol stack (layers)** reduces interaction between modules.
Modularity alone is not enough.

Avoiding complex interactions between network components.



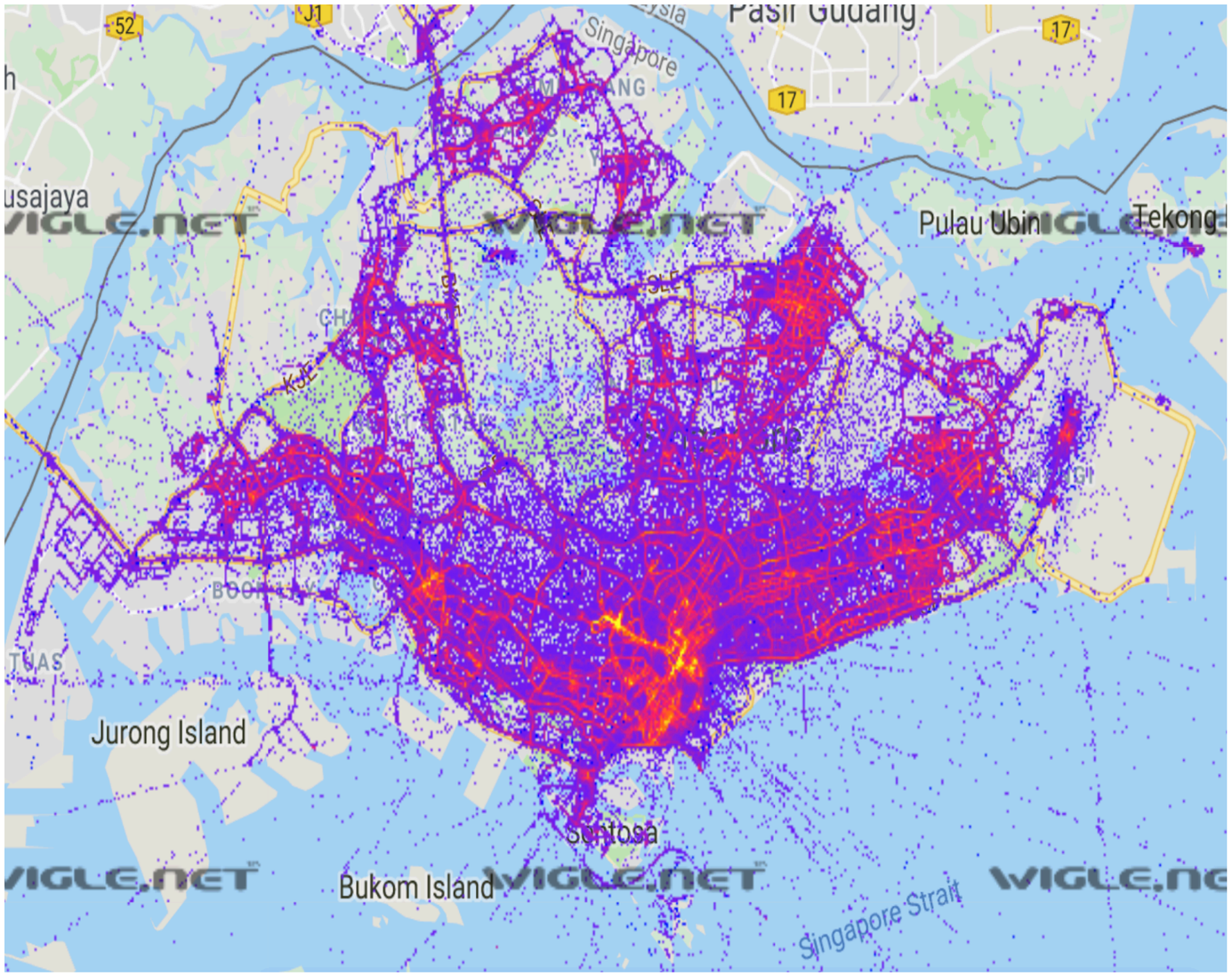
WHY IS LAYERING IMPORTANT?

Cons of **complex interactions** between so many different modules (network components):

1. You have **N^2** *possible interactions*, difficult to debug **and**
2. **Might lead to <u>emergent behavior</u>**

The number of possible interactions with N layers is N-1.

4.INTERNET HIERARCHY



Hierarchical structure supports **scalability**. Theres really alot of people that are using the internet, and this number is **growing, explosively.**

See: https://wigle.net

4. INTERNET HIERARCHY

Provides scalability