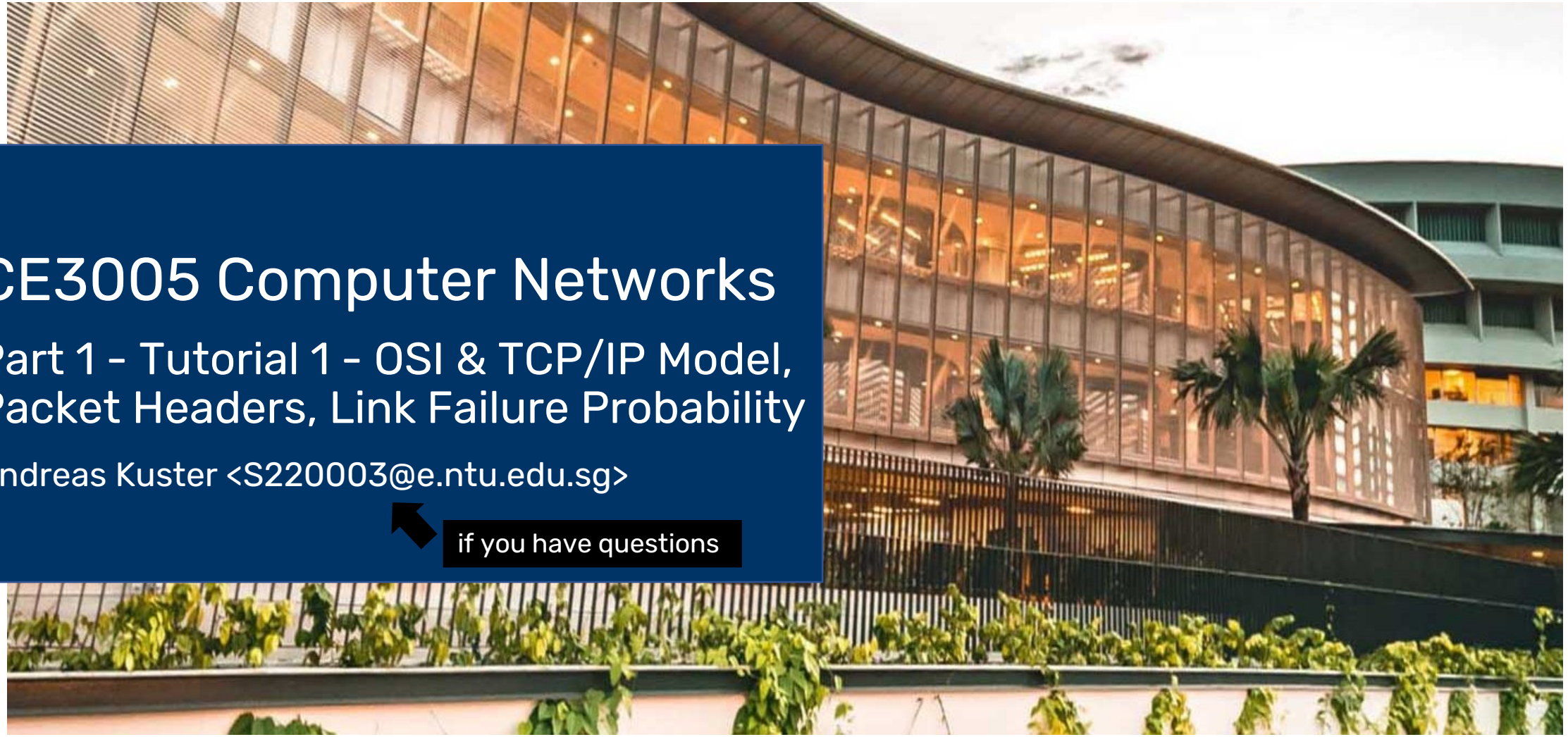
NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE

NTU IOT RESEARCH GROUP

WANDS wireless and networked distributed sensing group



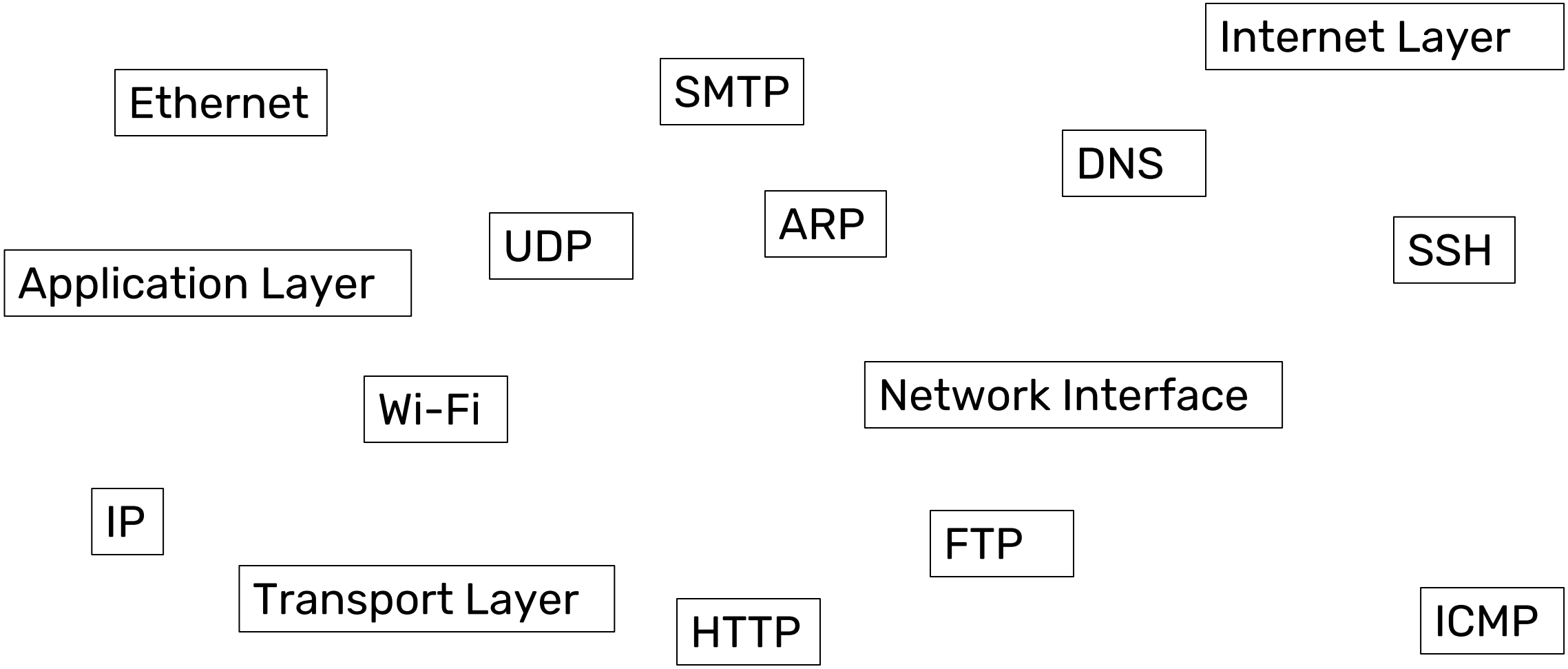
CE3005 Computer Networks

Part 1 - Tutorial 1 - OSI & TCP/IP Model, Packet Headers, Link Failure Probability

Andreas Kuster <S220003@e.ntu.edu.sg>

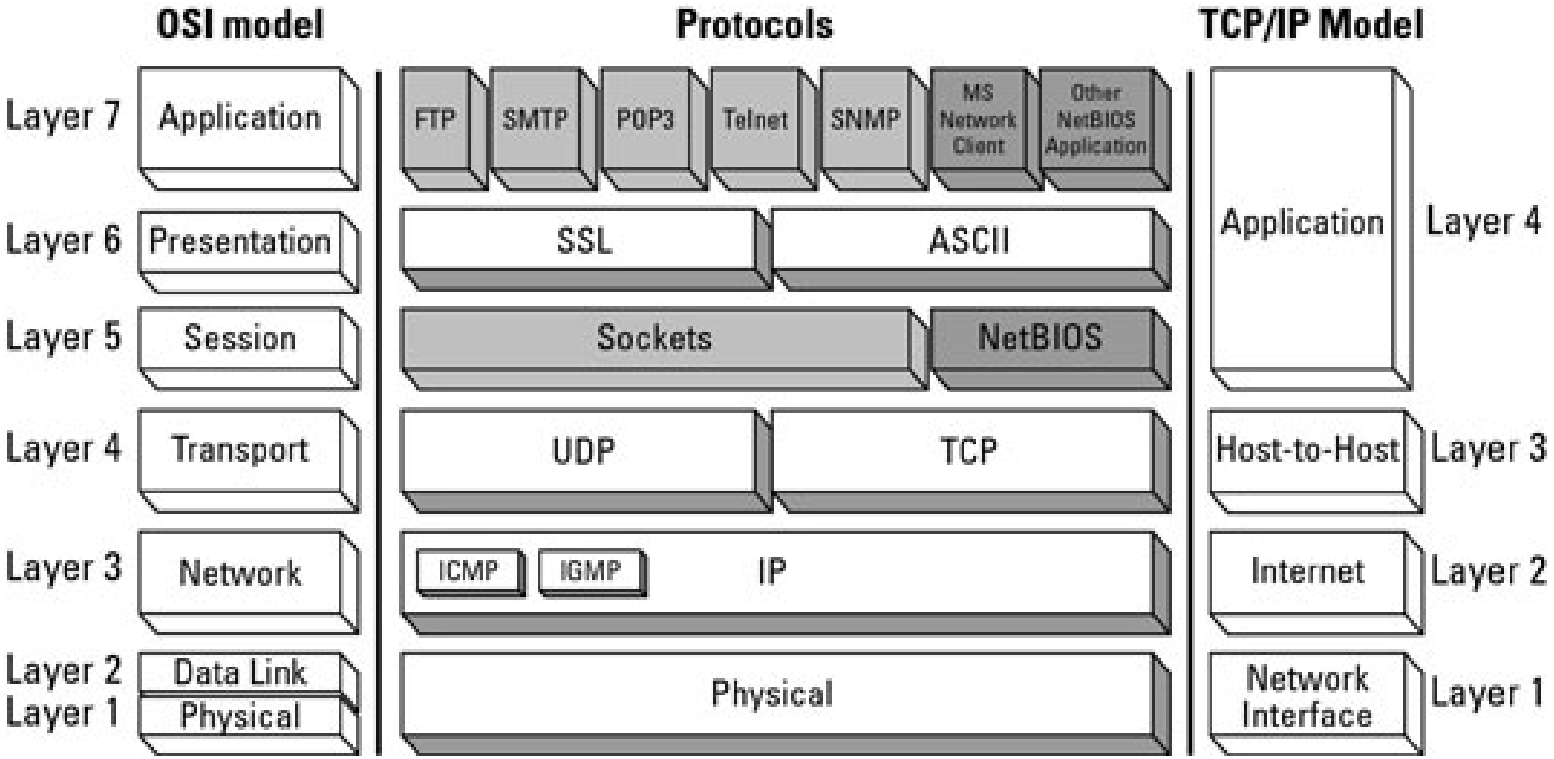
if you have questions

Q1: Group Exercise: TCP/IP Model



Q1: Comparison between TCP/IP and OSI Models

Demo
- ARP
- PING
- traceroute
- telnet/http



https://medium.com/

[Skip] Q1: OSI 7-Layer Model

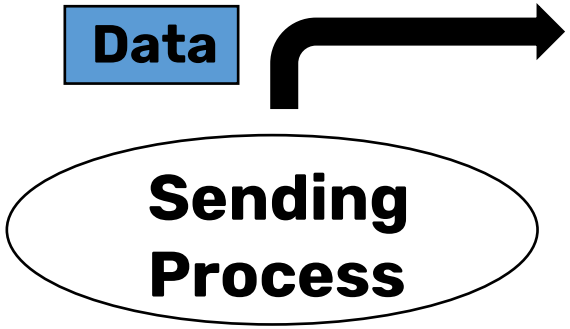
Layer	Name	Function
7	Application	Allows applications to request network services.
6	Presentation	Converts data so that systems that use different data formats can exchange information.
5	Session	Establishes sessions between network applications.
4	Transport	Provides for reliable delivery of packets.
3	Network	Handles routing of data across network segments.
2	Data Link	Provides MAC addresses to uniquely identify network nodes and a means for data to be sent over the Physical layer in the form of packets. Bridges and switches are layer 2 devices.
1	Physical	Governs the layout of cables (media) and devices such as repeaters and hubs.

OSI = Open Systems Interconnection

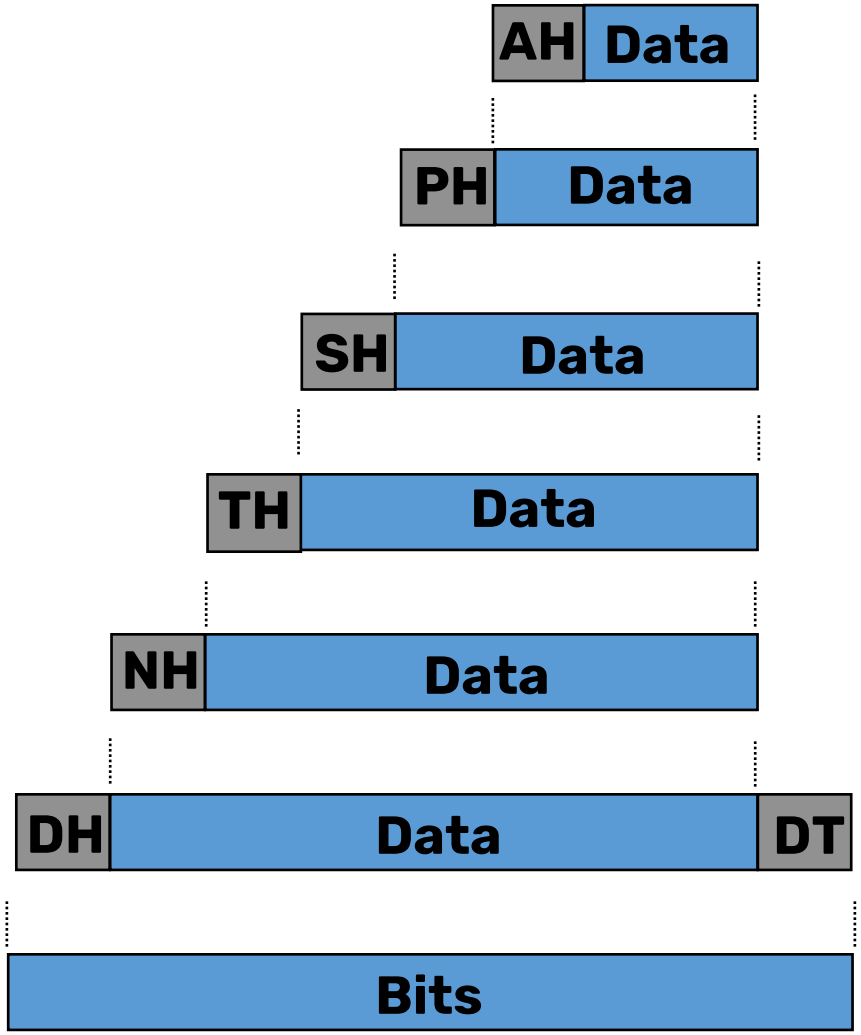
[Skip] Q1: Internet TCP/IP Model

Layer	Name	Function
5	Application	Acts as final endpoints at either end of a communication session between two network hosts
4	Transport	Manages the flow of traffic between two hosts or devices, ensuring that data arrives at the application on the host for which it is targeted
3	Internet (Network)	Contains all functionality that manages the movement of data between two network devices over a routed network
2	Link and Media Access	Deals with the network connectivity among neighboring devices.
1	Physical	Handles physical media and devices

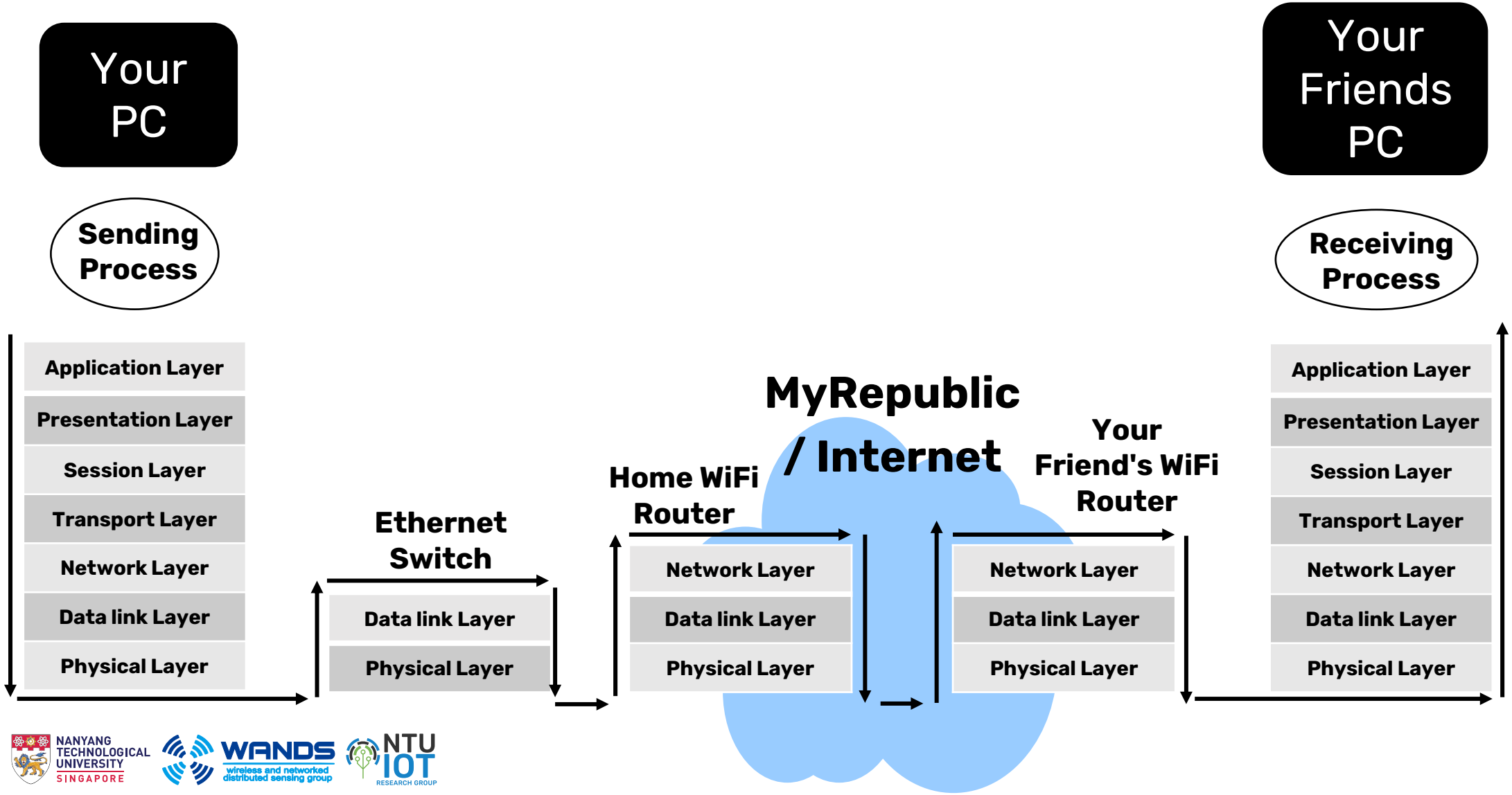
Q2: Protocol Stack at the Sender



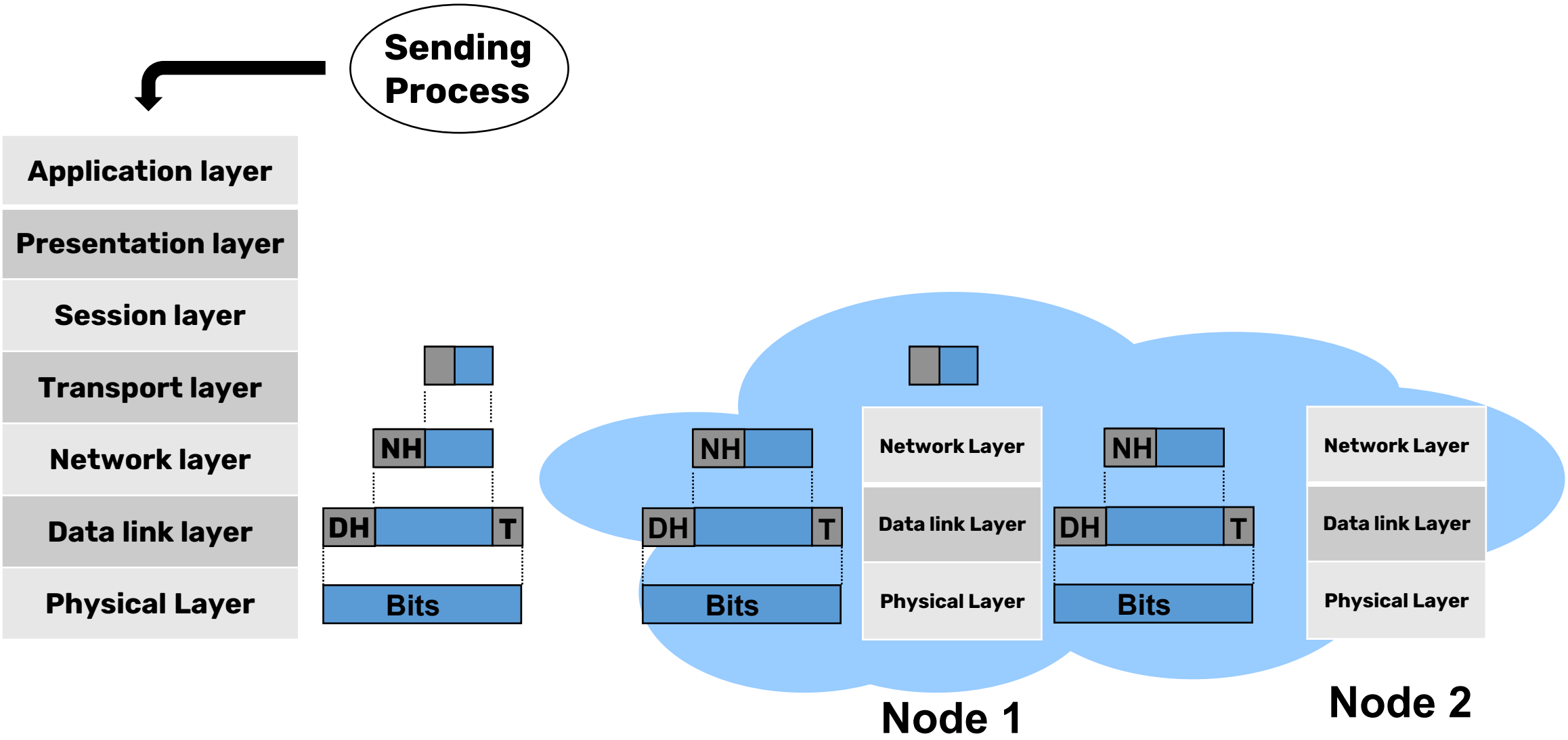
Application Layer
Presentation Layer
Session Layer
Transport Layer
Network Layer
Data link Layer
Physical Layer



Q2: A Simple Computer Network & OSI Model



Q2: Header Processing at the Switching Nodes



Q3: 6-9's Reliability

In network resilience, the link failure probability can be interpreted as the maximum permittable percentage of the time that the link goes down during a time window.

$$\underbrace{99.9999}_{\text{6x "9"}}\%$$

Calculate the duration (in seconds) of allowable downtime per year for this network?

Q3: 6-9’s Reliability

In this case, r = 99.9999%

b=1-r = 10-6

Failure probability = percentage of link downtime

Assume a regular year (365 days)

The allowable downtime per year is

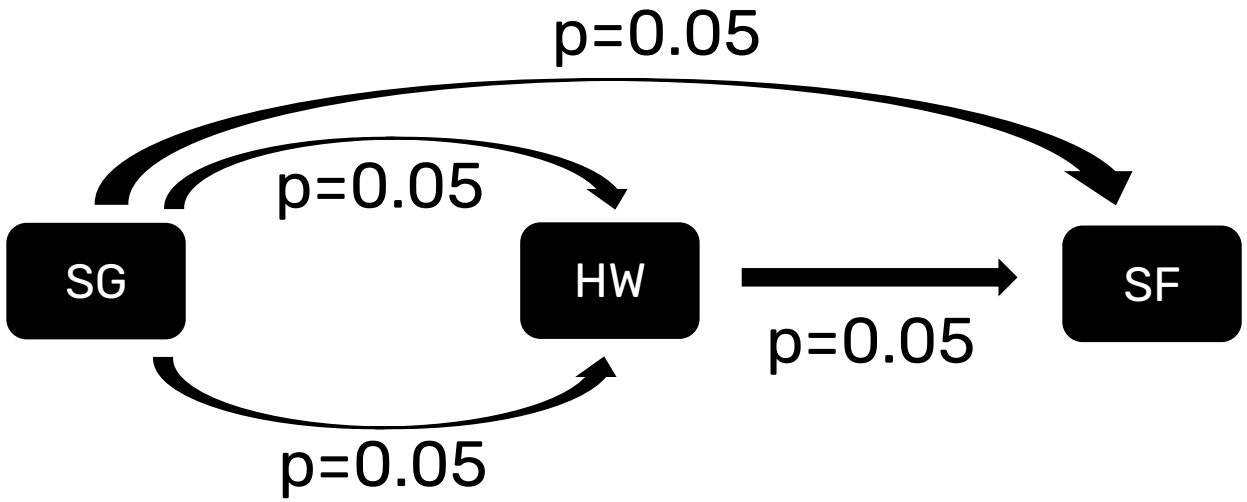
$$T = 365D \times 24H/D \times 60M/H \times 60\ S/M \times 10\text{-}6 = 31.5 \text{ seconds}$$

Q4: Network Resilience

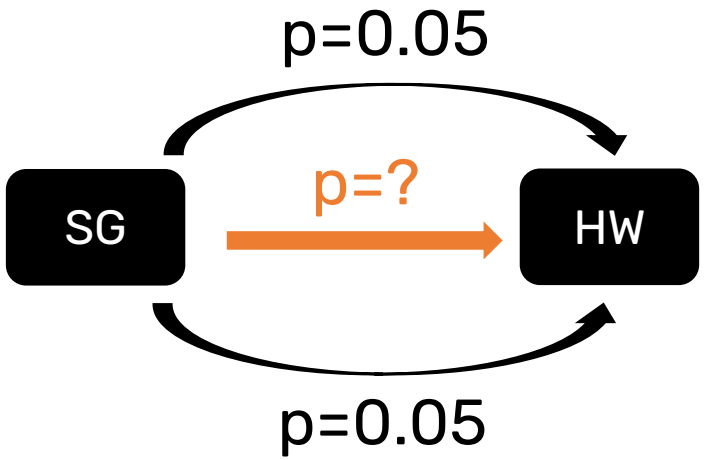
Singapore (SG) is connected to San Francisco (SF), via an intermediate node in Hawaii (HW).

Two independent links connect between Singapore and Hawaii, and a long-range link connects between Singapore and San Francisco. Assume that each link fails independently with probability of 0.05.

Calculate the probability in which SG is disconnected from SF.



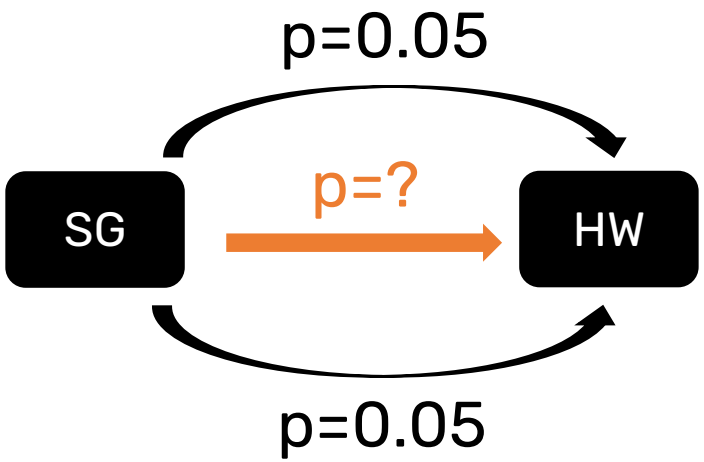
Q4: Network Resilience



Step 1: Calculate the resilience between SG and HW

$b_{SG\text{-}HW}$ = Pr[both upper and lower links fail]

Q4: Network Resilience

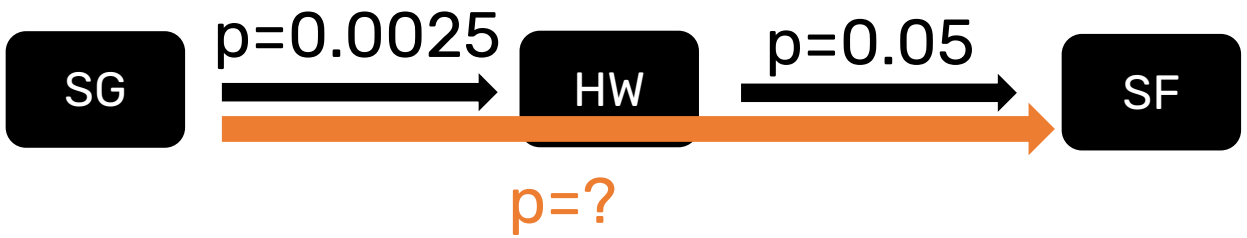


Step 1: Calculate the resilience between SG and HW

$b_{SG\text{-}HW}$ = Pr[both upper and lower links fail]

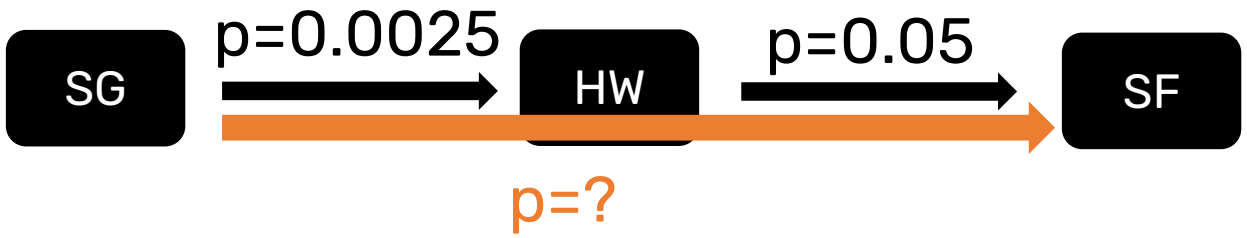
= *0.05 × 0.05 = 0.0025*

Q4: Network Resilience



Step 2: Calculate the resilience between SG and SF thru indirect link

Q4: Network Resilience



Step 2: Calculate the resilience between SG and SF thru indirect link

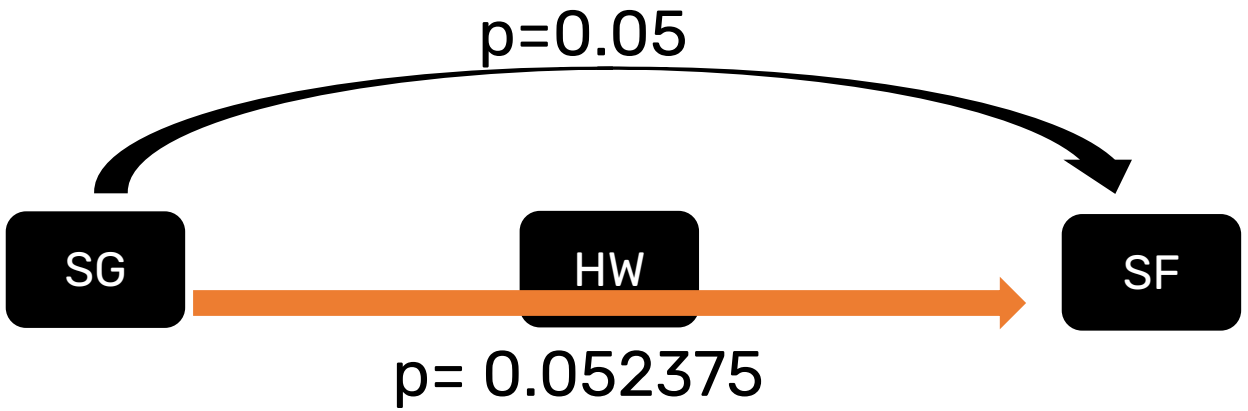
$r_{SG\text{-}HW\text{-}SF}$ = Pr[both SG-HW and HW-SF survive]

= *(1-0.0025) × (1-0.05) = 0.947625*

Step 3: Calculate the failure between SG and SF thru indirect link

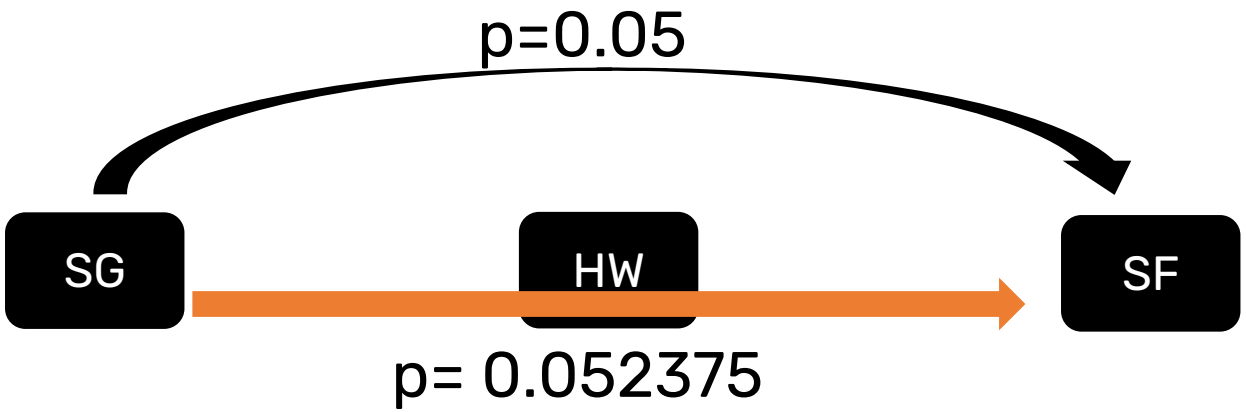
$b_{SG\text{-}HW\text{-}SF} = 1 - r_{SG\text{-}HW\text{-}SF} = 1 - 0.947625 = 0.052375$

Q4: Network Resilience



Step 4: Calculate the failure between SG and SF

Q4: Network Resilience



Step 4: Calculate the failure between SG and SF

$b_{SG\text{-}SF}$ = Pr[both direct and indirect paths fail]

= *0.05 × 0.052375 = 0.00261875*

Q4: How realistic is this?

Assume that **each link fails independently** with probability [..].

Questions?

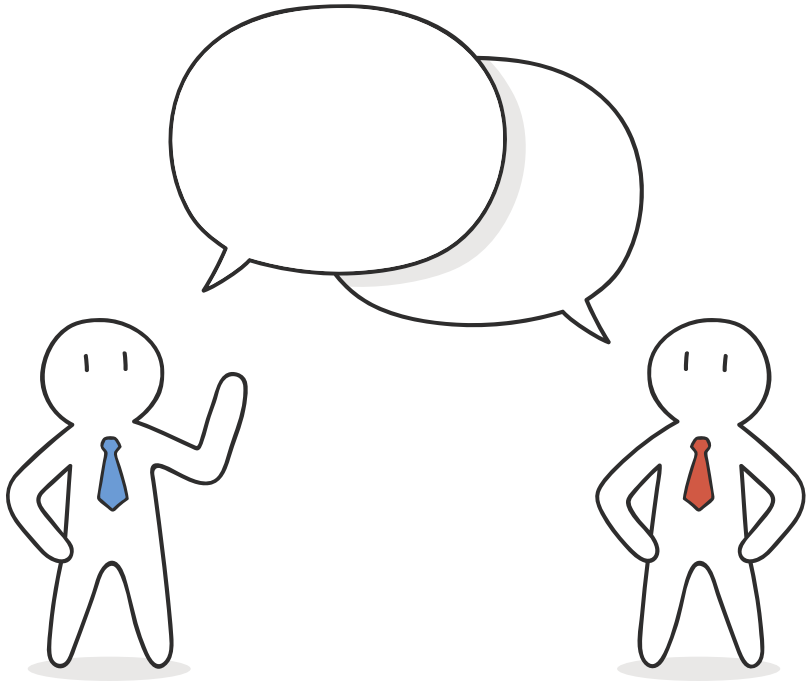


Image by dooder on Freepik