CE3005
Computer Networks

Part I - Tutorial 1

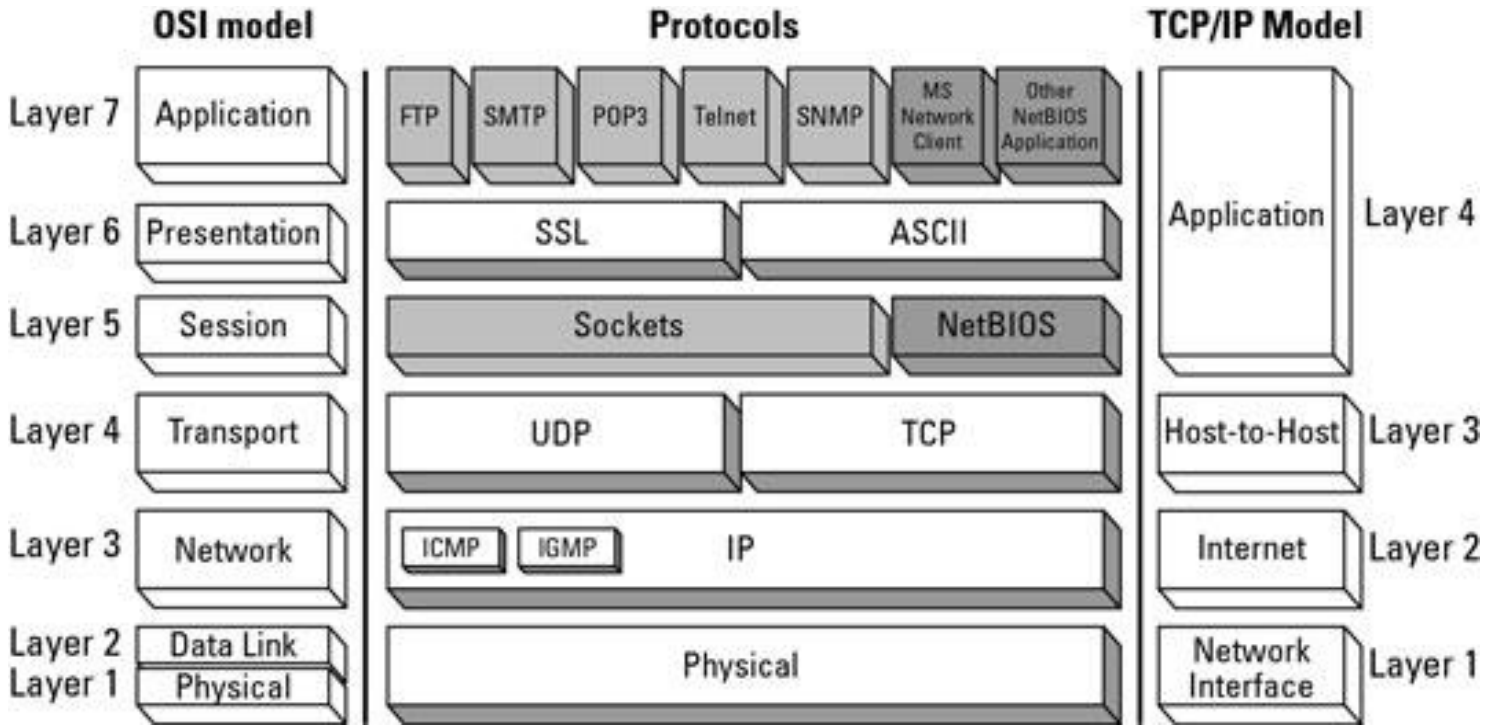
Q1: OSI 7-Layer Model

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.

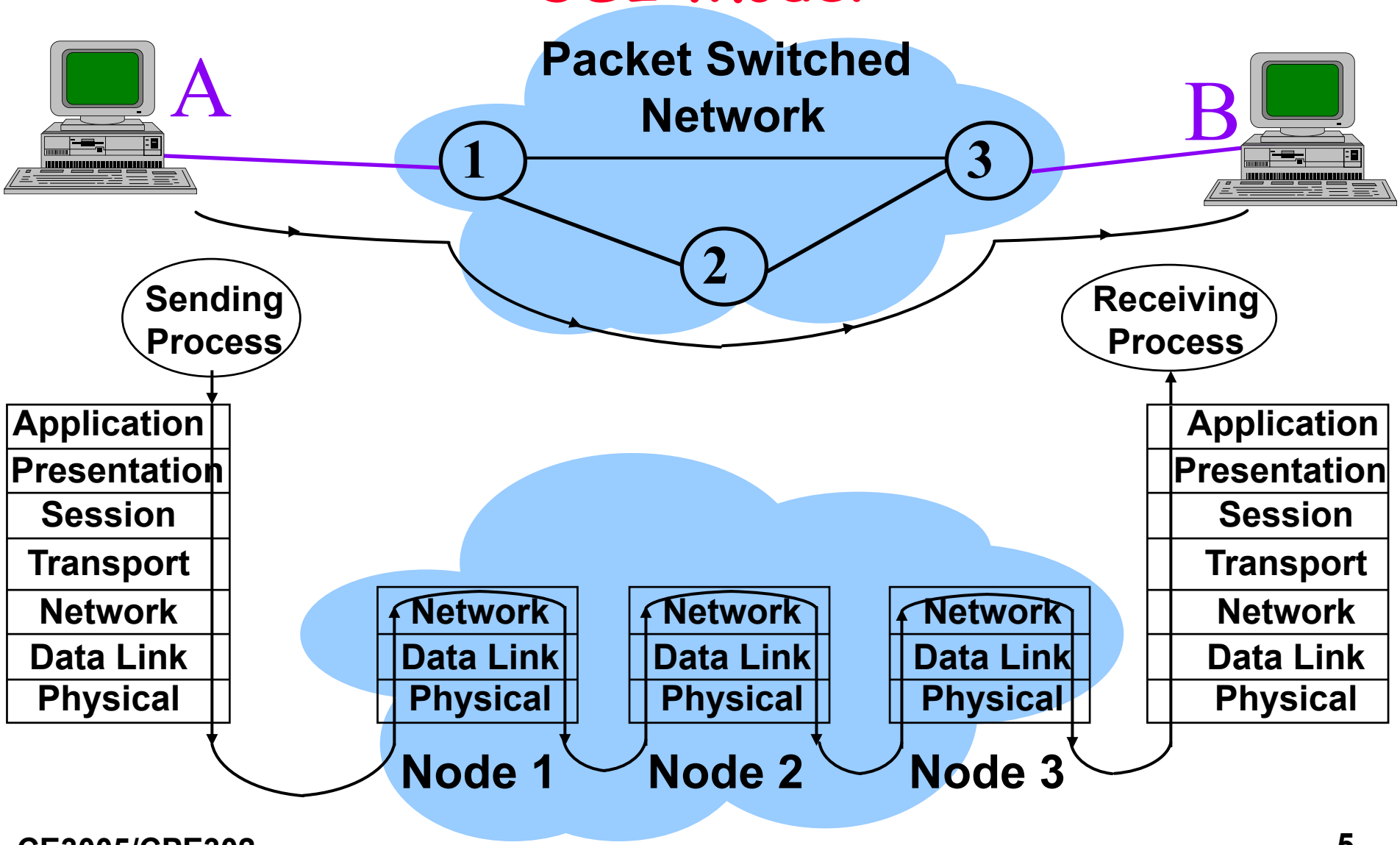
Q1: Internet TCP/IP Model

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

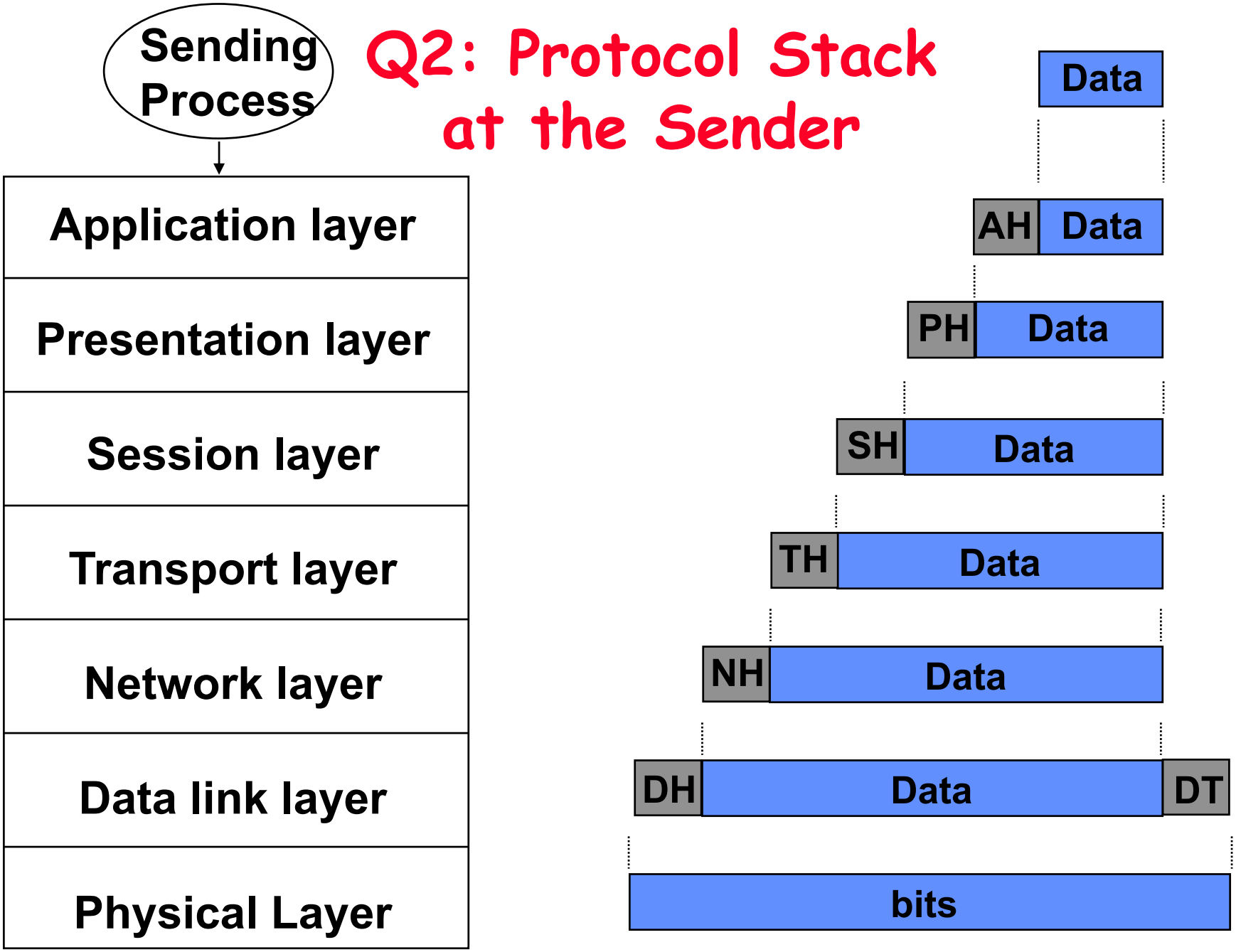
Q1: Comparison between TCP/IP and OSI Models



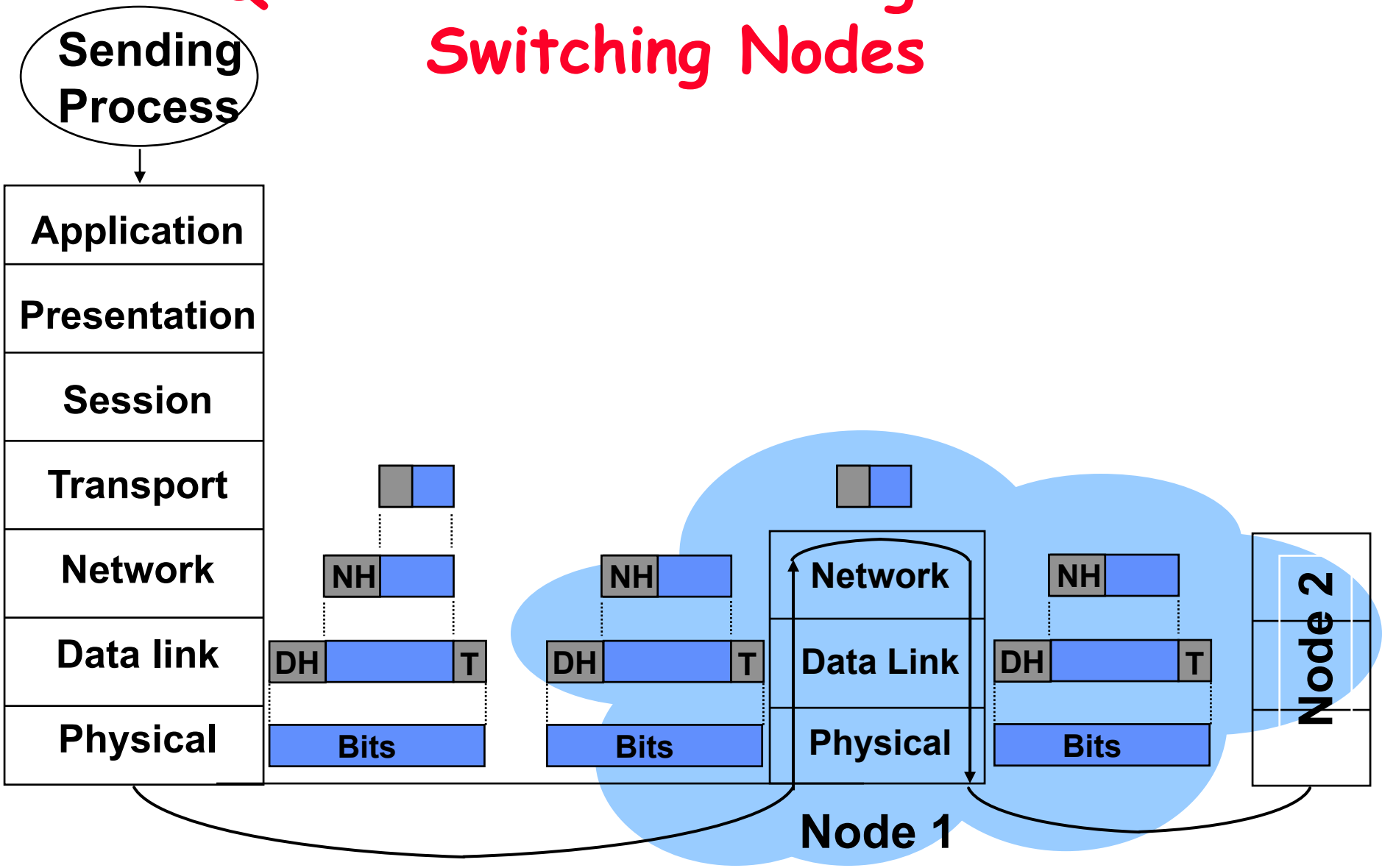
Q2: A Simple Computer Network & OSI Model



Q2: Protocol Stack at the Sender



Q2: Header Processing at the Switching Nodes



Q3: 6-9's Reliability

- In network resilience, the link failure probability can be interpreted as the percentage of the time that the link goes down during a time window. In a carrier-grade network, it is often required that the network should have 6 9's (i.e, 99.9999%) reliability. Please calculate the duration of allowable downtime per year for this network?

Q3: 6-9's Reliability

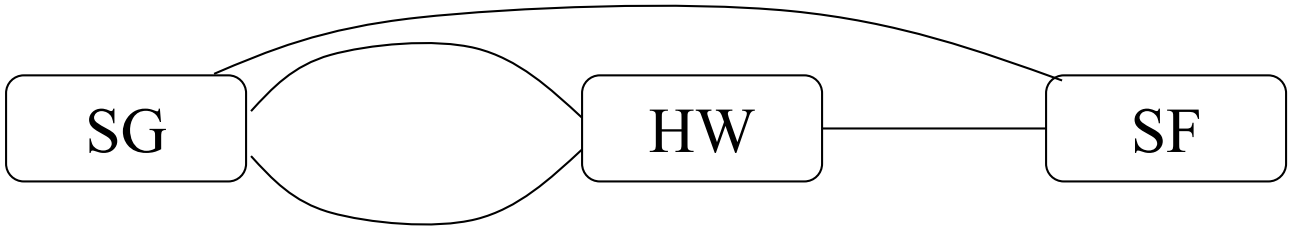
- In this case, r = 99.9999%
- b=1-r = 10^{-6}
  - ***Failure probability*** = *percentage of link downtime*
- Assume a regular year (365 days)
- The allowable downtime per year is

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

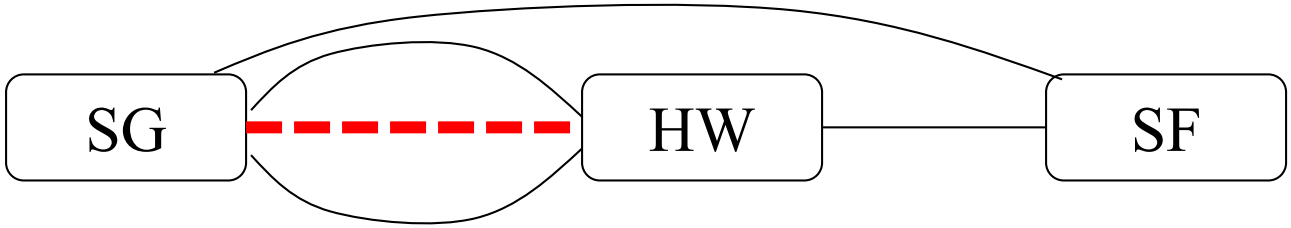
$$= 31.5\ seconds$$

Q4: Network Resilience

Singapore (SG) is connected to San Francisco (SF), via an intermediate node at 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

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

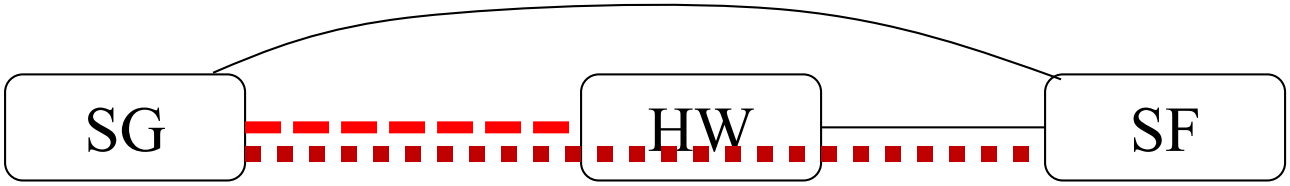
$= 0.05 \times 0.05 = 0.0025$

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

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

$= (1-0.0025) \times (1-0.05) = 0.947625$

Q4: Network Resilience



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

$b_{\text{SG-HW-SF}} = 1 - r_{\text{SG-HW-SF}} = 1 - 0.947625 = 0.052385$

Step 4: Calculate the failure between SG and SF

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

$= 0.05 \times 0.052385 = 0.00261875$