21ES614 – Internet of Things

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Syllabus

Unit 1

Introduction to IoT - Definitions, frameworks and key technologies. Functional blocks of IoT systems: hardware and software elements- devices, communications, services, management, security, and application. Challenges to solve in IoT

Unit 2

Basics of Networking & Sensor Networks - Applications, challenges - ISO/OSI Model, TCP/IP Model, Sensor network architecture and design principles, IoT technology stack, Communication models. Communication Protocols - Overview of protocols in each layer, Application protocols for the transfer of sensor data, Infrastructure for IoT: LoRa-Wan, 6LoWPAN, 5G and Sigfox.

Unit 3

Introduction to Cloud, Fog and Edge Computing. Modern trends in IoT – Industrial IoT, Wearable. Applications of IoT - Smart Homes/Buildings, Smart Cities, Smart Industry, and Smart Medical care, Smart Automation etc.

Transport Layer - Revisiting

- Port addressing (Process to Process – End to End delivery)
- Segmentation and reassembly
- Connection control
- Flow control
- Error control
- Network Application & System Software

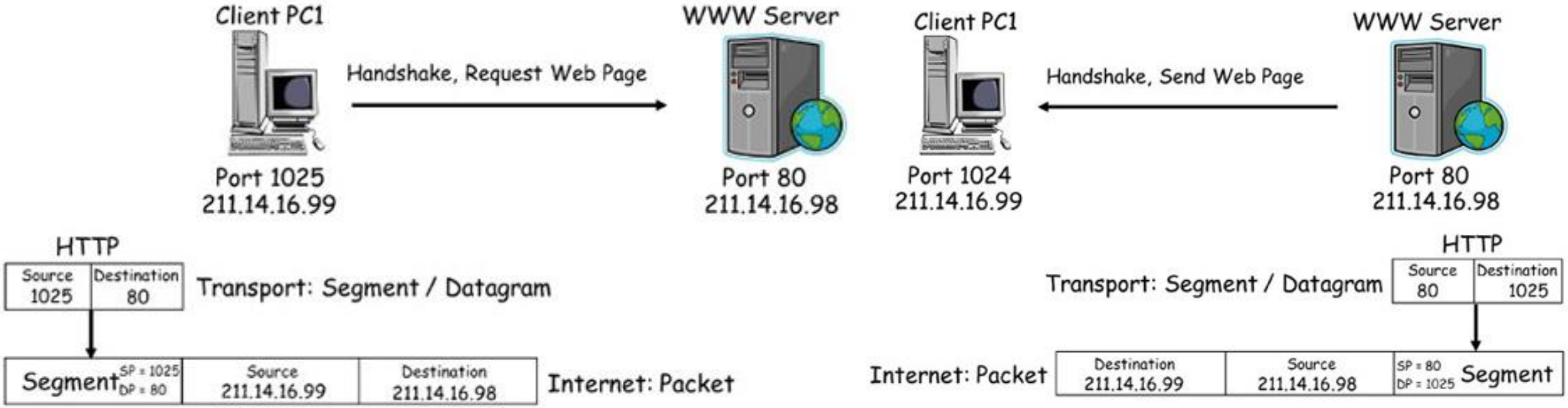
Ref: https://networkhope.in/iso-osi-basic-reference-model/
http://cs.uok.edu.in/Files/79755f07-9550-4aeb-bd6f-5d802d56b46d/Custom/ADC%20unit%202.pdf
https://www.studytonight.com/computer-networks/complete-osi-model
https://www.geeksforgeeks.org/layers-of-osi-model/

Transport Layer - Port

- Port addressing (Process to Process – End to End delivery)
- Port number - a way to identify a specific process to which an internet or other network message is to be forwarded when it arrives at a node
- Well-known ports (0 to 1023). These are reserved, and are commonly used by HTTP, SMTP, POP3, FTP, DNS, etc.
- Registered ports (1024 to 49151). These are assigned to user processes or applications, typically programs that you have chosen to install on your computer that require network connectivity (e.g. games and messaging services).
- Dynamic or private ports (49152 to 65535). These are assigned dynamically to client applications when the client initiates a connection to a service.

Ref: https://www.techtarget.com/searchnetworking/definition/port-number
https://www.open.edu/openlearncreate/mod/oucontent/view.php?id=129631&section=7
https://www.iana.org/assignments/service-names-port-numbers/service-names-port-numbers.xhtml

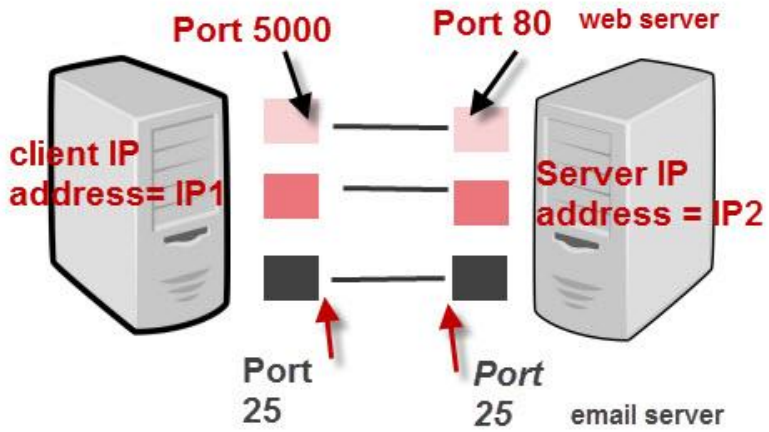
Transport Layer - Port



Ref: https://www.techtarget.com/searchnetworking/definition/port-number
https://www.open.edu/openlearncreate/mod/oucontent/view.php?id=129631&section=7
https://www.iana.org/assignments/service-names-port-numbers/service-names-port-numbers.xhtml

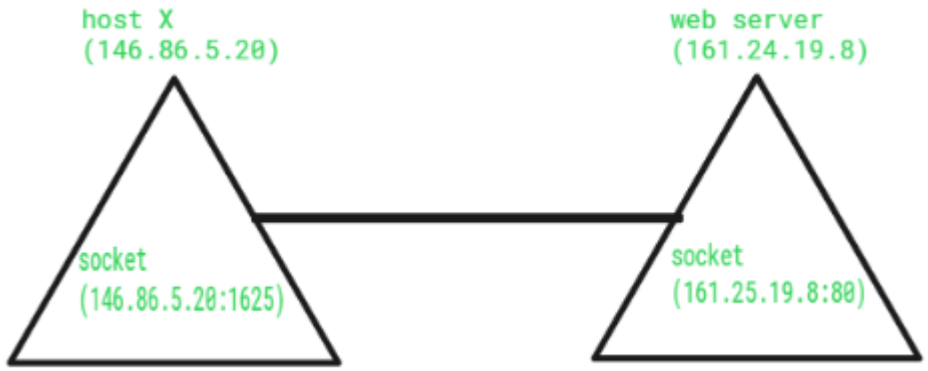
Transport Layer – TCP Socket

- **Socket** is one endpoint of a **two way** communication link between two programs running on the network.



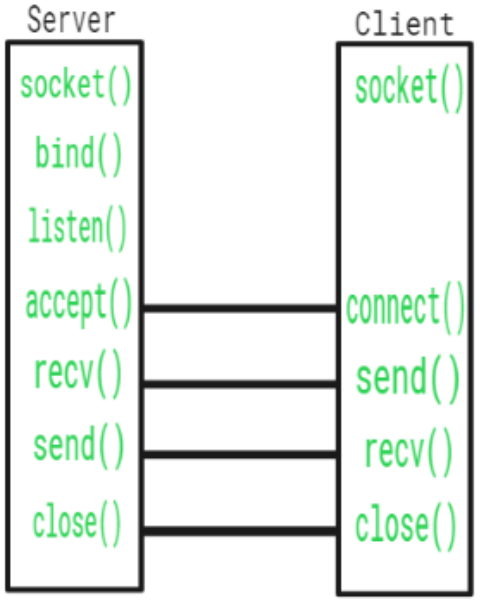
IP Address + Port number = Socket

TCP/IP Ports And Sockets



Ref: http://www.steves-internet-guide.com/tcpip-ports-sockets/
http://web.deu.edu.tr/doc/oreily/networking/tcpip/ch02_07.htm
https://www.geeksforgeeks.org/socket-in-computer-network/

Transport Layer – TCP Socket



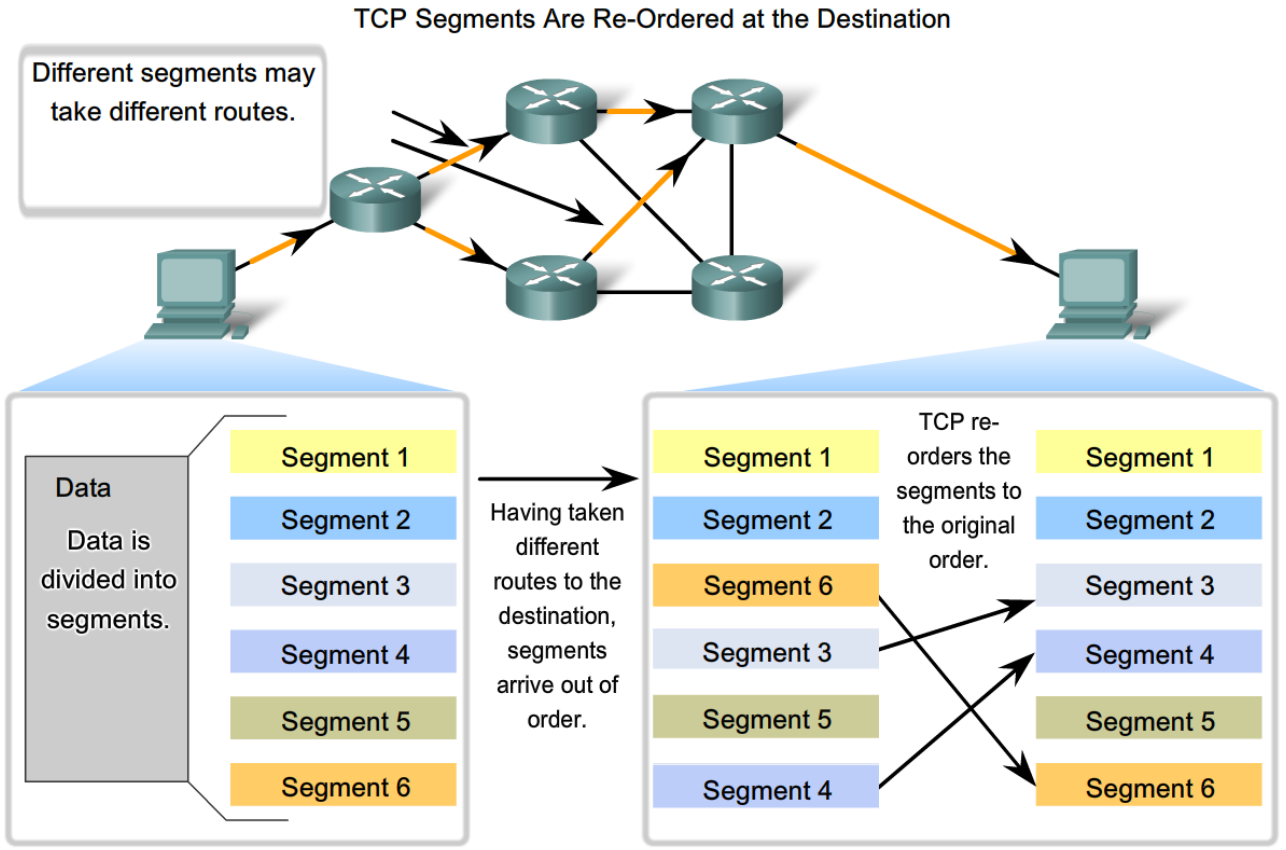
- **Datagram**
  - Connection less point for sending and receiving packets.
- **Stream** socket
  - A connection-oriented, sequenced, and unique flow of data with well defined mechanisms for creating and destroying connections and for detecting errors.

Ref: http://www.steves-internet-guide.com/tcpip-ports-sockets/
http://web.deu.edu.tr/doc/oreily/networking/tcpip/ch02_07.htm
https://www.geeksforgeeks.org/socket-in-computer-network/

Transport Layer - Segmentation and Reassembly

- Segmentation
  - Dividing data into segments
- Reassembly
  - Joining segments to form data

- Sequence Numbers



Ref: https://cis.msjc.edu/Tutorials/Networking/OSIModel/transport/
http://www.cnt4all.com/2016/08/07-transport-layer-segmentation.html

Transport Layer – Connection Control

TCP – Transmission Control Protocol

- Connection-oriented protocol
- Stream data transfer
- Reliability – Acknowledgement based
- Flow Control – Window/Ack
- Multiplexing
- Logical Connections
- Segmentation

UDP – User Datagram Protocol

- Connectionless protocol
- Non-sequenced transport functionality
- Multiplexing
- Used when reliability and security are less important than speed and size

TCP Segment

Bit (0)	Bit (15)	Bit (16)	Bit (31)
Source Port (16)		Destination Port (16)	
Sequence Number (32)			
Acknowledgement Number (32)			
Header Length (4) Reserved (6) Code Bits (6)		Window (16)	
Checksum (16)		Urgent (16)	
Options (0 or 32 if any)			
APPLICATION LAYER DATA (Size varies)			

20 Bytes

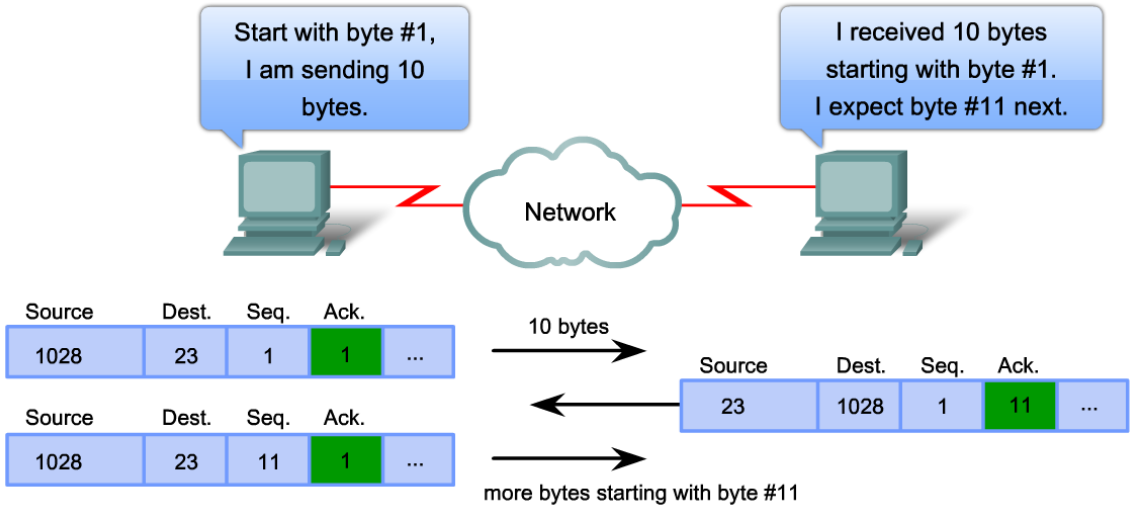
UDP Datagram

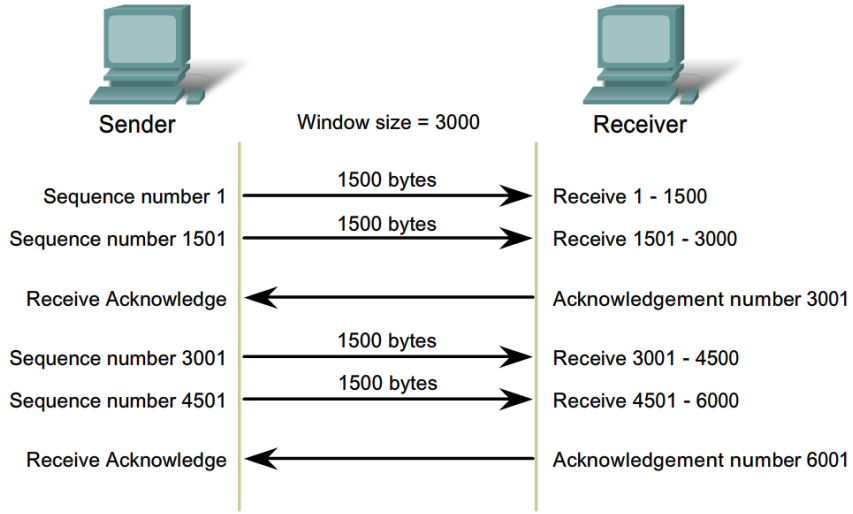
Bit (0)	Bit (15)	Bit (16)	Bit (31)
Source Port (16)		Destination Port (16)	
Length (16)		Checksum (16)	
APPLICATION LAYER DATA (Size varies)			

8 Bytes

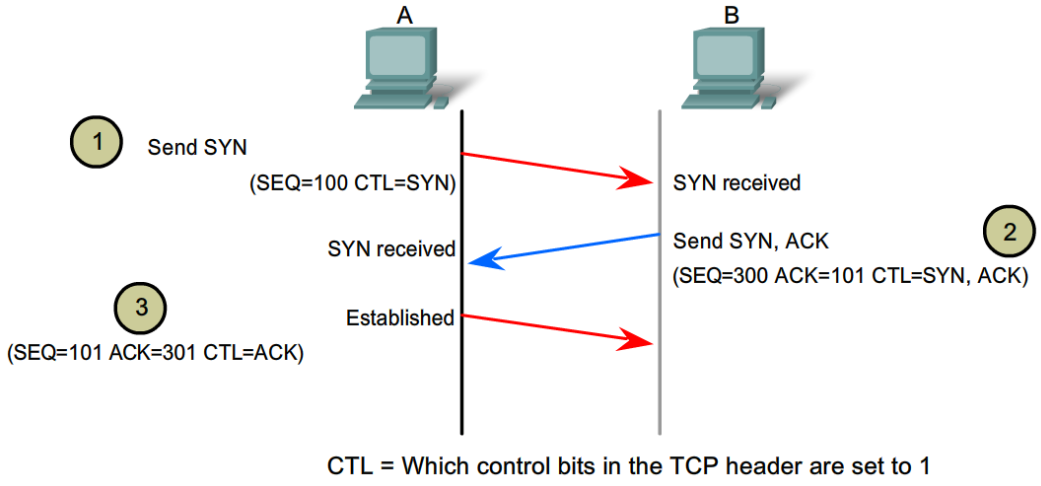
Ref: https://www.javatpoint.com/computer-network-transport-layer-protocols
https://www.geeksforgeeks.org/tcp-and-udp-in-transport-layer/
https://cis.msjc.edu/Tutorials/Networking/OSIModel/transport/

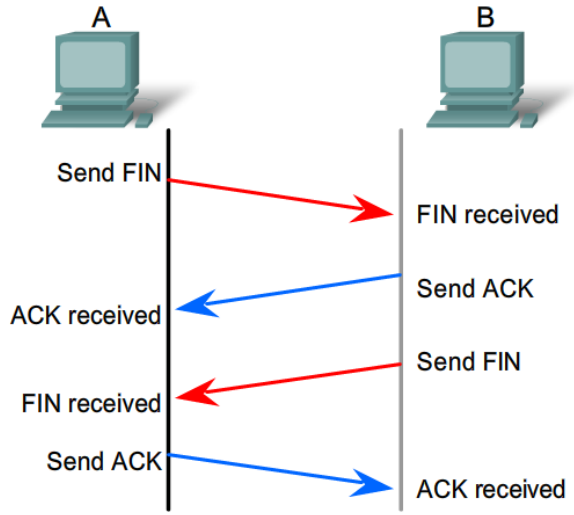
Transport Layer – Connection Control - TCP





The window size determines the number of bytes sent before an acknowledgment is expected.
The acknowledgement number is the number of the next expected byte.

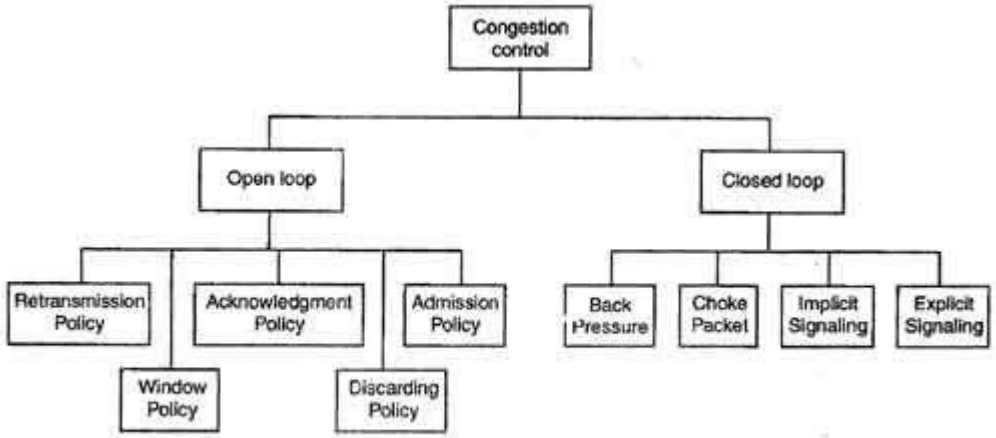




Ref: https://cis.msjc.edu/Tutorials/Networking/OSIModel/transport/

Transport Layer – Congestion Control

- Occurs when the load on the network (i.e. the number of packets sent to the network) is greater than the capacity of the network (i.e. the number of packets a network can handle)
- Multiple factors cause congestion

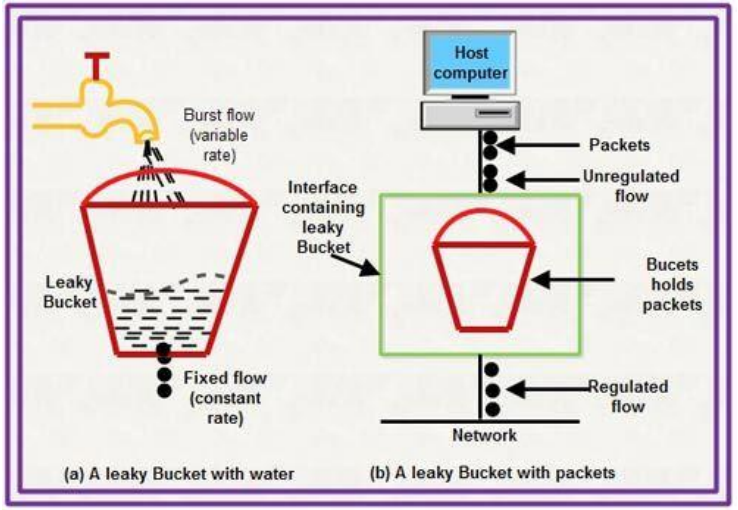


Types of Congestion Control Methods

Ref: https://ecomputernotes.com/computernetworkingnotes/communication-networks/what-is-congestion-control-describe-the-congestion-control-algorithm-commonly-used
https://www.tutorialspoint.com/what-is-congestion-control-algorithm

Transport Layer – Congestion Control Algorithms

- Leaky bucket
  - It is a traffic shaping mechanism that controls the amount and the rate of the traffic sent to the network.
  - A leaky bucket algorithm shapes bursty traffic into fixed rate traffic by averaging the data rate.



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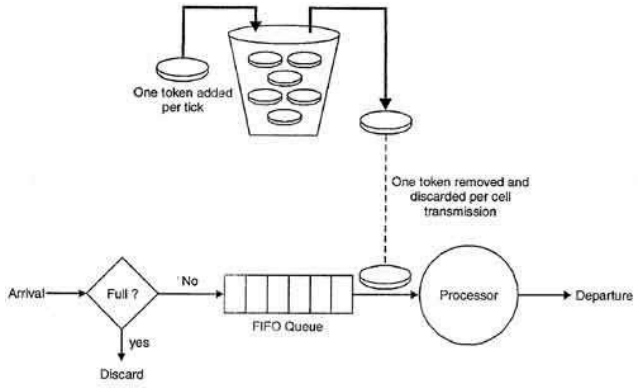
Transport Layer – Congestion Control Algorithms

- Token bucket
  - A token bucket algorithm allows bursty data transfers
  - Tokens are generated at every clock tick. For a packet to be transmitted, system must remove token(s) from the bucket
  - Thus, a token bucket algorithm allows idle hosts to accumulate credit for the future in form of tokens.



Token bucket algorithm

Ref: https://www.tutorialspoint.com/what-is-congestion-control-algorithm
https://ecomputernotes.com/computernetworkingnotes/communication-networks/what-is-congestion-control-describe-the-congestion-control-algorithm-commonly-used

Transport Layer – Congestion Control Algorithms

- Load Shedding
  - Router contains a buffer to store packets and route it to destination. When the buffer is full, it simply discards some packets.
  - Load shedding will use dropping the old packets than new to avoid congestion.
  - To implement an intelligent discard policy, applications must mark their packets to indicate to the network how important they are. When packets have to be discarded, routers can first drop packets from the least important class, then the next most important class, and so on.

Ref: https://www.tutorialspoint.com/what-is-congestion-control-algorithm
https://www.tutorialspoint.com/what-is-load-shedding-in-computer-networks

Thank You…