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ALOHA Protocol

The ALOHA protocol is one of the earliest forms of wireless communications systems and was developed by Norman Abramson at the University of Hawaii in the 1970s. ALOHA is a method of medium access control (MAC) that allows multiple users to send data over a shared communication medium.

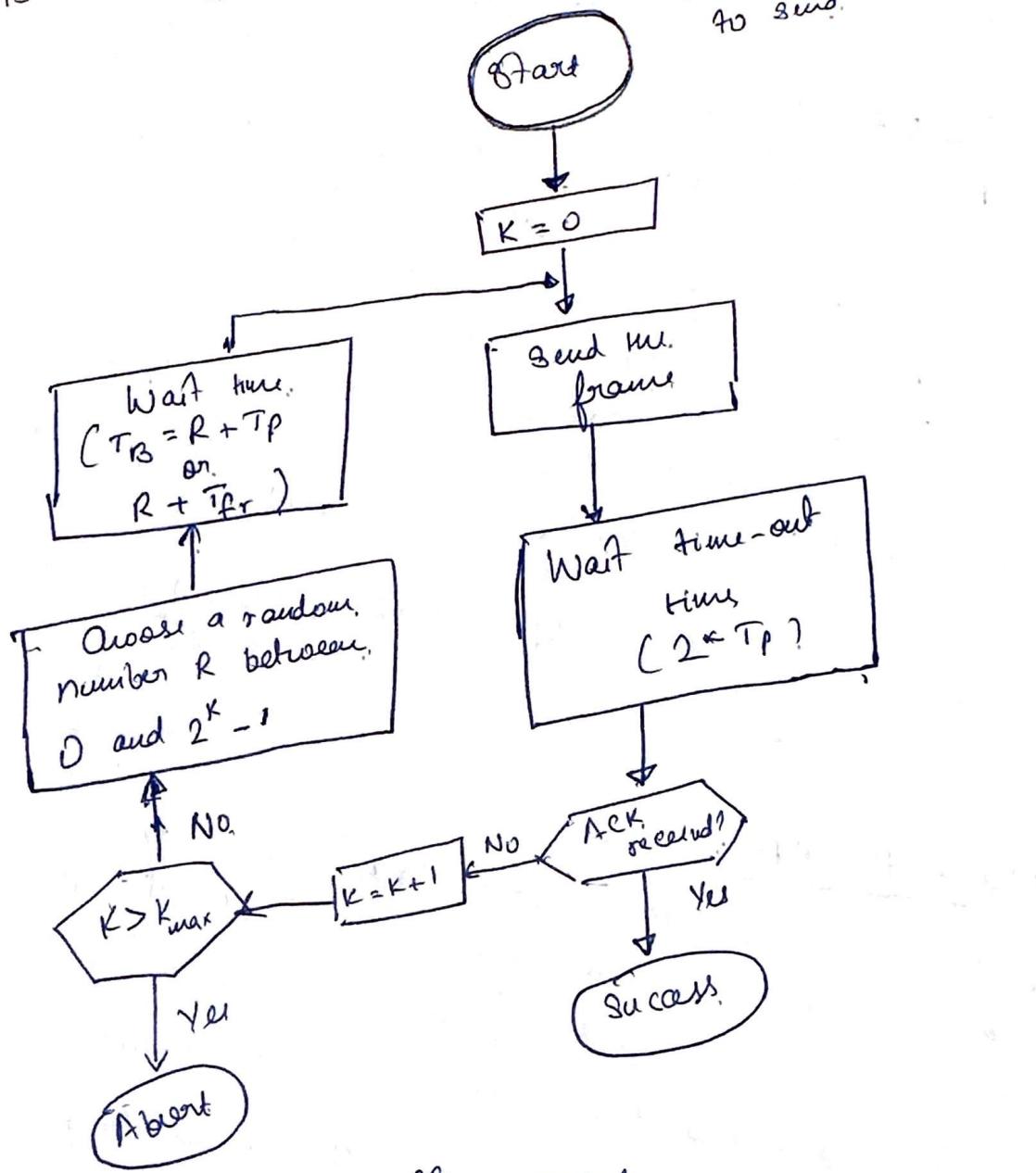
The two types of ALOHA are Pure ALOHA and Slotted ALOHA.

Pure ALOHA

- In Pure ALOHA, user transmit data as soon as they have it, without checking if the channel is busy. If two packets collide, both are destroyed, and the users must wait a random amount of time before retransmitting.
- There is no synchronization between the users. collisions can happen at any time, reducing the efficiency of the network.

and

- K : Number of attempts
- T_p : Maximal propagation time
- T_{ff} : Average transmission time for a frame
- T_{B3} : Back-off time



Throughput $S = G_1 \cdot e^{-2G}$, where.

$G \rightarrow$ throughput (average successful packet transmission rate),

(1) \rightarrow average number of packet transmission attempts during one packet time:

maximum throughput, $S_{\max} = \frac{1}{Qe} \approx 0.184$

or 18.4%

(2)

example
if two user transmit data at approximately the same time, their packets collide, both fail, and must wait a random amount of time before retransmitting.

Slotted ALOHA

- > Overview: To improve the efficiency of PURE ALOHA, Slotted ALOHA was introduced. In this system, time is divided into discrete slots, each equal length. Users must wait for one packet token mission time. Slot to transmit for the beginning of a time slot like likelihood of their packets. This reduces collisions.
- > Transmission can only begin at the start of a time slot.
- > Reduces the chance of collision by ensuring that all transmissions are synchronised with the slots.
- > Throughput $S = G e^{-G}$, where
• G is the average number of transmission attempts per time slot.
- Maximum Throughput: $S_{max} = \frac{1}{e} \approx 0.368$ or 36.8%

IEEE 802

Example: By transmitting only at the start of a slot, two nodes minimize the chance of their packets colliding, allowing for more successful transmission.

Aspect	Pure ALOHA	Dotted ALOHA
Time synchronization	No	Yes
Maximum throughput	1 - e ⁻ⁿ	36.8%
Collision occurrence	Anytime during transmission.	Only at the beginning of slots.

Applications of ALOHA

Pure and Dotted ALOHA protocols were used in early wireless communication systems like satellite networks and also laid the groundwork for modern MAC protocols in technologies such as Ethernet and Wi-Fi. RFID (Radio Frequency Identification) systems also implement ALOHA for tag communication.

IEEE 802

The IEEE 802 Standards focus on local area networks (LANs) and metropolitan area networks (MANs). These Standards primarily cover the lower two layers of the OSI model: the Physical layer (Layer 1) and Data Link layer. The Standards are maintained by the IEEE 802 LAN/MAN Standards Committee.

IEEE 802.3 (Ethernet)

- > Defines wired Ethernet technology which is the most widely used LAN technology today. Initially designed for 10 Mbps speeds, Ethernet has evolved to offer gigabit and even faster speeds.
- > MAC Protocol: Uses Carrier Sense Multiple Access / Collision Detection (CSMA/CD) to avoid collision on a shared medium.
- > Frame Structure: Ethernet frames include the following parts:
- Preamble: synchronization for receiver.
 - Destination and Source MAC address:
 - Identifies sender and receiver.
 - Payload: the data being transmitted.
 - Cyclic Redundancy Check (CRC): For error detection.

Ethernet (IEEE 802.3) Frame Format diagram

Preamble	S F D	Destination Address	Source Address	Length	Data	CRC
7 bytes	1 byte	6 bytes	6 bytes	2 bytes	46-1500 bytes	4 bytes

IEEE 802.11 (wifi)

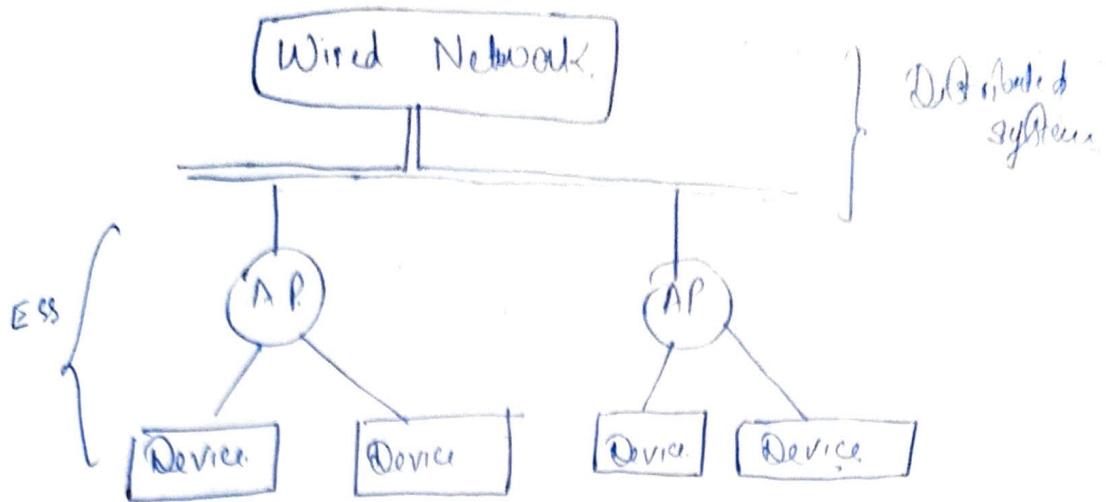
> Wi-Fi is a wireless LAN technology, specified under the IEEE 802.11 standard. Various versions of the standard have been developed to support higher data rates and better performance including 802.11 b/g/n/ac/ax.

> Frequencies: Operates in the 2.4 GHz and 5 GHz frequency bands.

> MAC Protocol: Uses carrier sense multiple access / collision avoidance (CSMA/CA) due to the difficulty of detecting collisions in wireless communication.

Security Protocol

- WEP (Wired Equivalent Privacy) - Outdated and insecure.
- WPA/WPA2 (Wi-Fi Protected Access) - Provides enhanced security for Wi-Fi networks.
- WPA3 - latest security standard with stronger encryption.



Applications:
 Wi-Fi is used extensively in homes, offices, and public areas to provide wireless access. Versions like 802.11ax (Wi-Fi 6) offer fast speeds and better handling of multiple devices.

IEEE 802.15 (Bluetooth and PAN)

> The IEEE 802.15 Standard deals with Wireless Personal Area Networks (WPANs), which provide proximity communication between devices in close proximity. Bluetooth is a prominent technology that falls under this standard.

> Bluetooth operates over short distances (up to 100 meters) and is commonly used for connecting peripherals like wireless keyboards, mice, and headphones to computers and smartphones.

Application: Bluetooth is used for data transfer between personal smart devices like wireless head phones, fitness trackers and devices for connecting

IEEE 802.16 (WiMax)

- > IEEE 802.16, commonly known as WiMax (Worldwide Interoperability for Microwave Access), is a standard for broadband wireless access over long distances. WiMAX is used primarily for providing internet access in rural and underserved areas.
- > Operated in licensed and unlicensed frequency bands, typically in the 2-11 GHz and 10-66 GHz ranges.
- > Can provide internet access over distances of several kilometers, making it suitable for metropolitan area networks (MANs).

Application

Used to provide internet services in areas where traditional wired broadband is unavailable or costly to deploy.