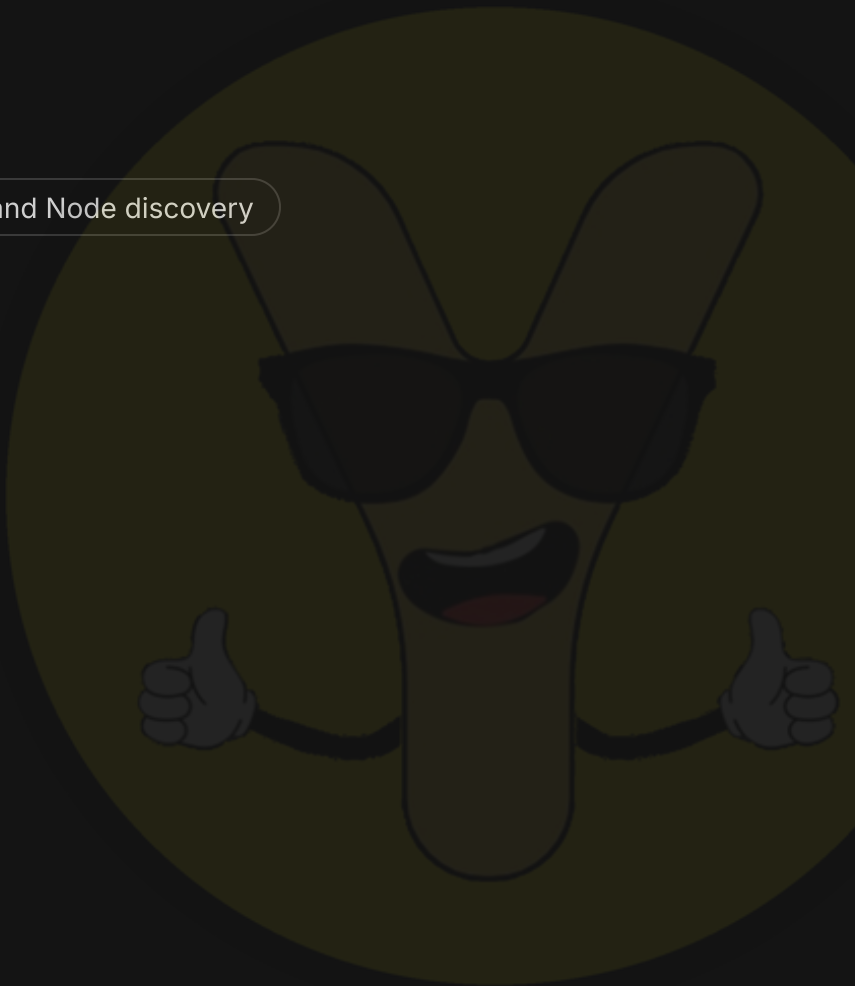
AKTU · 4TH YEAR · SEMESTER 7 · BCS070

Internet of Things

Unit 3 — Network and Communication Aspects in IoT

- Wireless Medium access issues
- MAC protocol survey
- Survey routing protocols
- Sensor deployment and Node discovery
- Data aggregation and dissemination



DECODED BY

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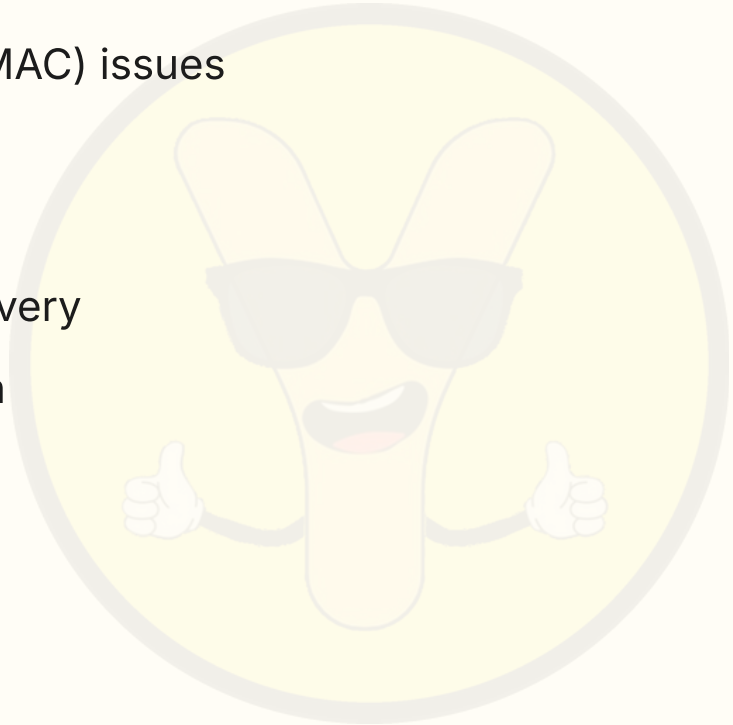
Unit 3: Network and Communication Aspects in IoT

Overview of communication challenges and protocols in IoT networks.

- Wireless Medium Access Control (MAC) issues
- MAC protocol survey for IoT
- Survey of routing protocols
- Sensor deployment and node discovery
- Data aggregation and dissemination



Wireless Medium Access Issues

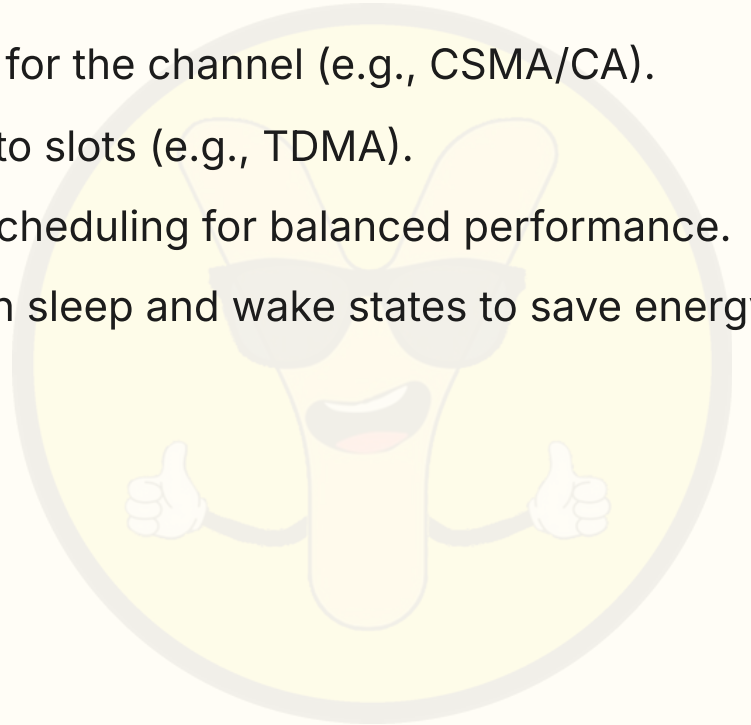
Challenges in sharing the wireless medium in IoT environments.

- Hidden Terminal Problem: Nodes out of range of each other interfere at the receiver.
- Exposed Terminal Problem: Nodes refrain from sending unnecessarily due to overhearing neighbors.
- Collision: Simultaneous transmissions lead to packet loss.
- Energy Efficiency: Idle listening and overhearing consume significant battery power.
- Scalability: High node density leads to increased contention and latency.

MAC Protocol Survey

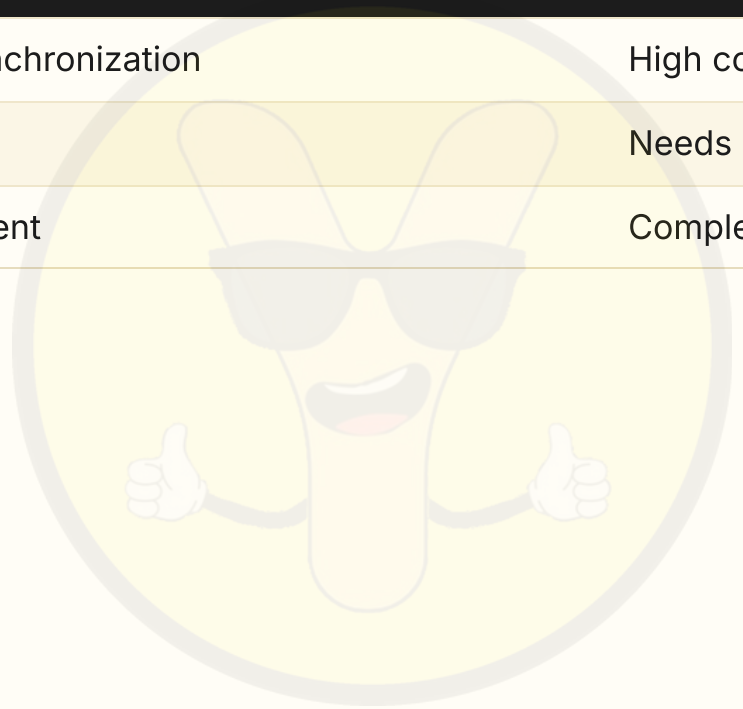
Categorization of MAC protocols based on medium access strategy.

- Contention-based: Nodes compete for the channel (e.g., CSMA/CA).
- Schedule-based: Time is divided into slots (e.g., TDMA).
- Hybrid: Combines contention and scheduling for balanced performance.
- Duty-cycled: Nodes switch between sleep and wake states to save energy.



Comparison of MAC Protocols

Protocol Type	Advantage	Disadvantage
CSMA/CA	Simple, no synchronization	High collision rate
TDMA	No collisions	Needs strict synchronization
Hybrid	Flexible, efficient	Complex implementation

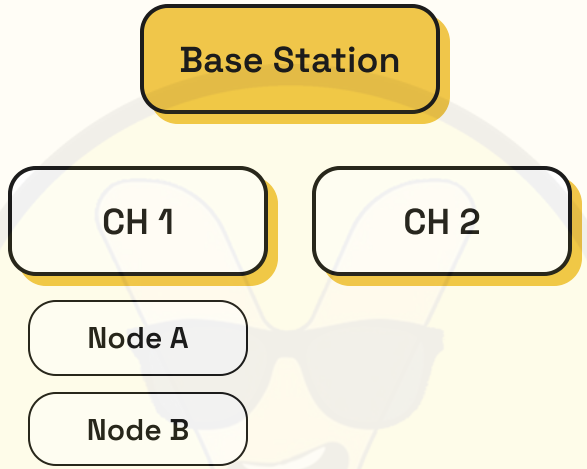


Survey of Routing Protocols

Routing strategies for resource-constrained IoT devices.

- Flat Routing: All nodes have equal roles; data is flooded or gossiped.
- Hierarchical Routing: Nodes are grouped into clusters; Cluster Heads (CH) manage data.
- Location-based: Routing depends on physical coordinates of nodes.
- Data-centric: Routing based on the content of the data (e.g., Directed Diffusion).

Hierarchical Routing Architecture

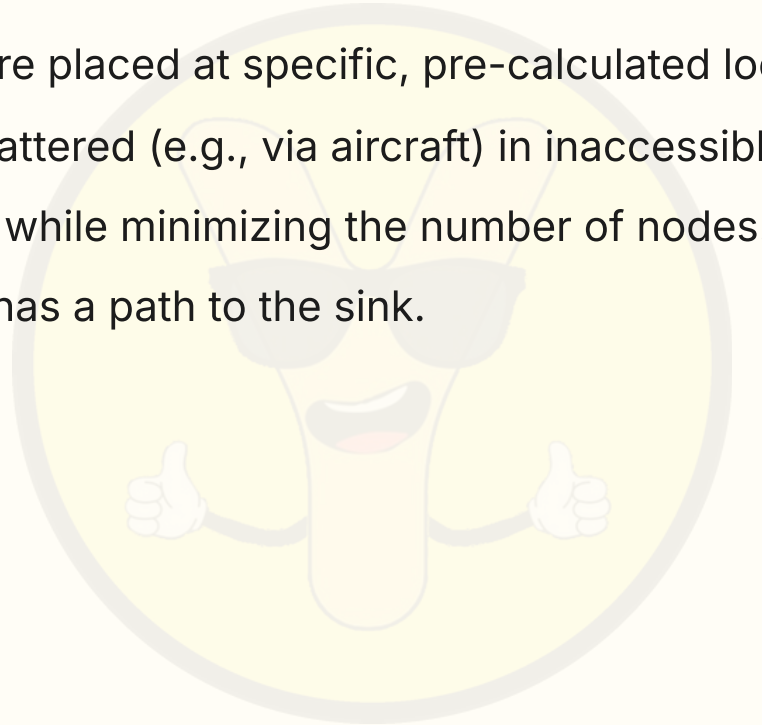


Cluster-based routing where nodes report to a Cluster Head.

Sensor Deployment

Strategies for placing sensors in the environment.

- Deterministic Deployment: Nodes are placed at specific, pre-calculated locations.
- Random Deployment: Nodes are scattered (e.g., via aircraft) in inaccessible areas.
- Objective: Maximize coverage area while minimizing the number of nodes.
- Connectivity: Ensuring every node has a path to the sink.



Node Discovery

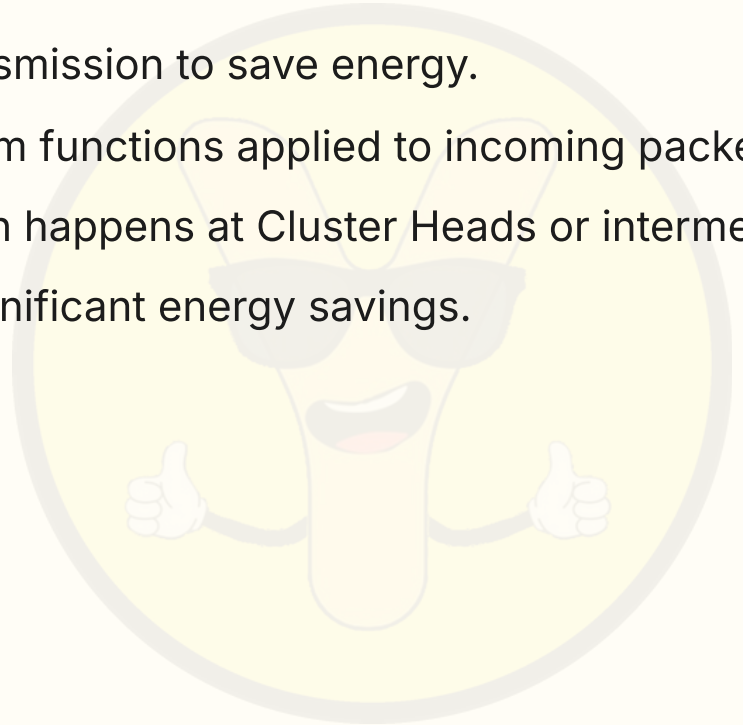
The process of identifying neighbors and network topology.

- Hello Packets: Nodes broadcast presence messages periodically.
- Passive Discovery: Nodes listen to traffic to identify neighbors.
- Active Discovery: Nodes send probes to request neighbor information.
- Neighbor Table: A local data structure storing IDs and signal strength of neighbors.

Data Aggregation

Reducing data volume by combining information at intermediate nodes.

- Goal: Minimize redundant data transmission to save energy.
- Methods: Average, Max, Min, or Sum functions applied to incoming packets.
- In-network processing: Aggregation happens at Cluster Heads or intermediate routers.
- Trade-off: Increased latency vs. significant energy savings.

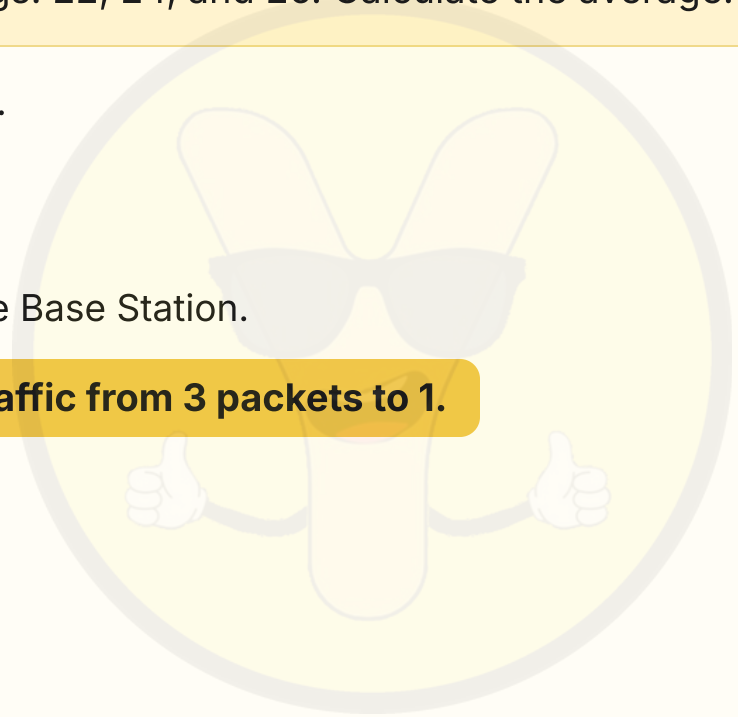


Data Aggregation Example

Three sensors send temperature readings: 22, 24, and 26. Calculate the average.

1. Collect data packets at the Cluster Head.
2. Apply formula: $Avg = \frac{\sum_{i=1}^{n} x_i}{n}$
3. Calculate: $Avg = \frac{22+24+26}{3} = 24$
4. Transmit only the single result (24) to the Base Station.

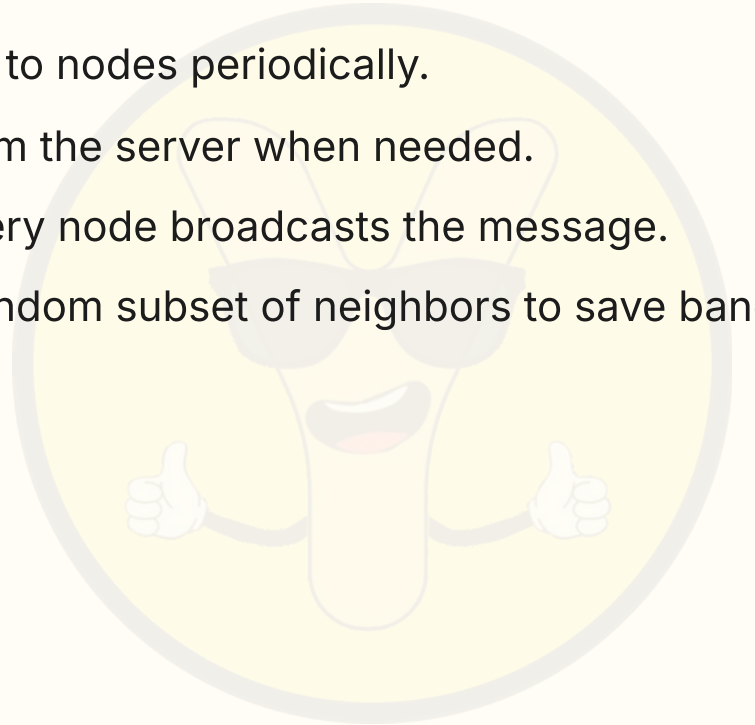
The aggregated value is 24, reducing traffic from 3 packets to 1.



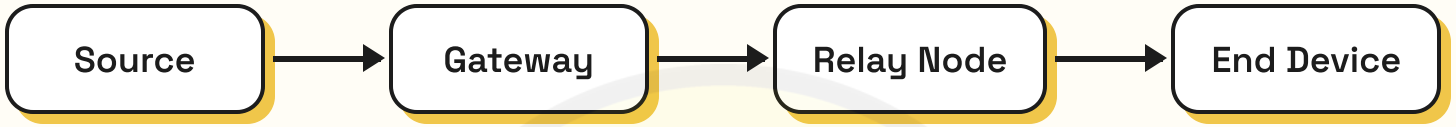
Data Dissemination

The process of spreading information or commands through the network.

- Push-based: Server sends updates to nodes periodically.
- Pull-based: Nodes request data from the server when needed.
- Flooding: Simple but inefficient; every node broadcasts the message.
- Gossiping: Nodes send data to a random subset of neighbors to save bandwidth.



Data Dissemination Flow

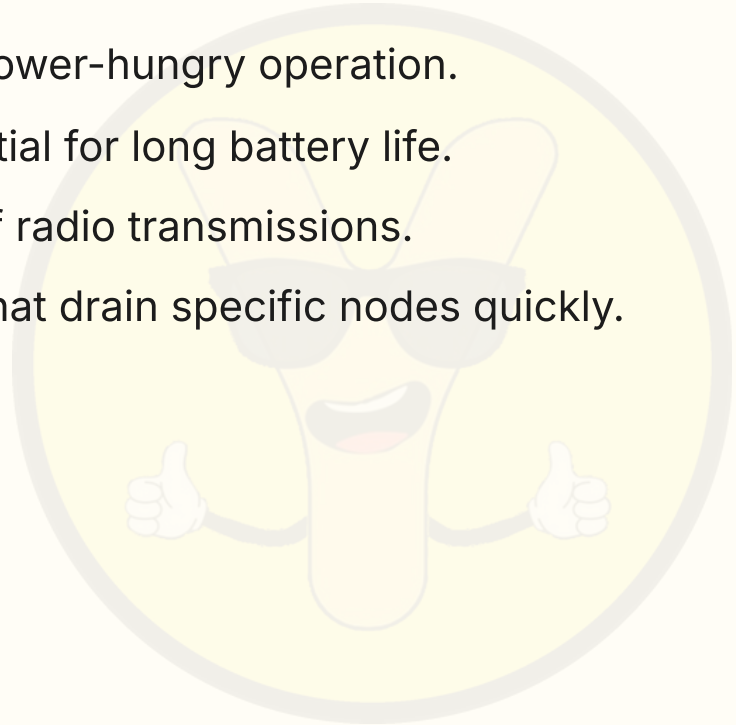


Information flow from source to end devices.

Energy Considerations

Why energy is the primary constraint in IoT communication.

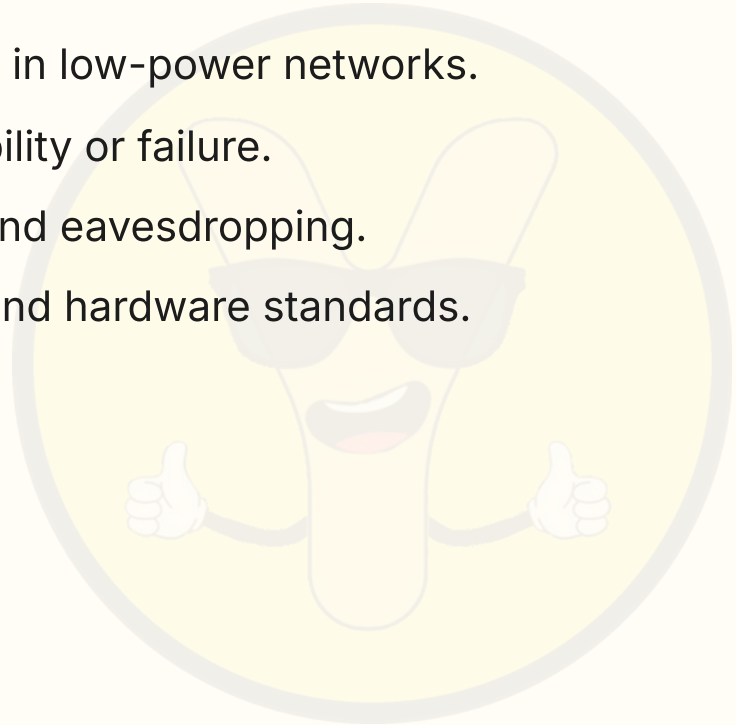
- Radio communication is the most power-hungry operation.
- Duty cycling (Sleep/Wake) is essential for long battery life.
- Aggregation reduces the number of radio transmissions.
- Efficient routing avoids 'hotspots' that drain specific nodes quickly.



Challenges in IoT Networks

Summary of technical hurdles.

- Limited bandwidth and high latency in low-power networks.
- Dynamic topology due to node mobility or failure.
- Security: Vulnerability to jamming and eavesdropping.
- Interoperability: Diverse protocols and hardware standards.



Exam corner

- **Q1** Explain the Hidden and Exposed terminal problems in wireless MAC.
- **Q2** Differentiate between Contention-based and Schedule-based MAC protocols.
- **Q3** Describe the role of Cluster Heads in hierarchical routing.
- **Q4** What is data aggregation? Explain its importance in IoT networks.
- **Q5** Explain the process of node discovery in a wireless sensor network.
- **Q6** Compare flooding and gossiping techniques for data dissemination.
- **Q7** Why is energy efficiency critical in IoT communication design?

Unit 3 done. You are exam-ready.

Revise the Exam corner once more, then open Unit 4 on theycotes.com. Every AKTU subject, unit by unit, free. Notes by Chirag Jain, Ycotes.

