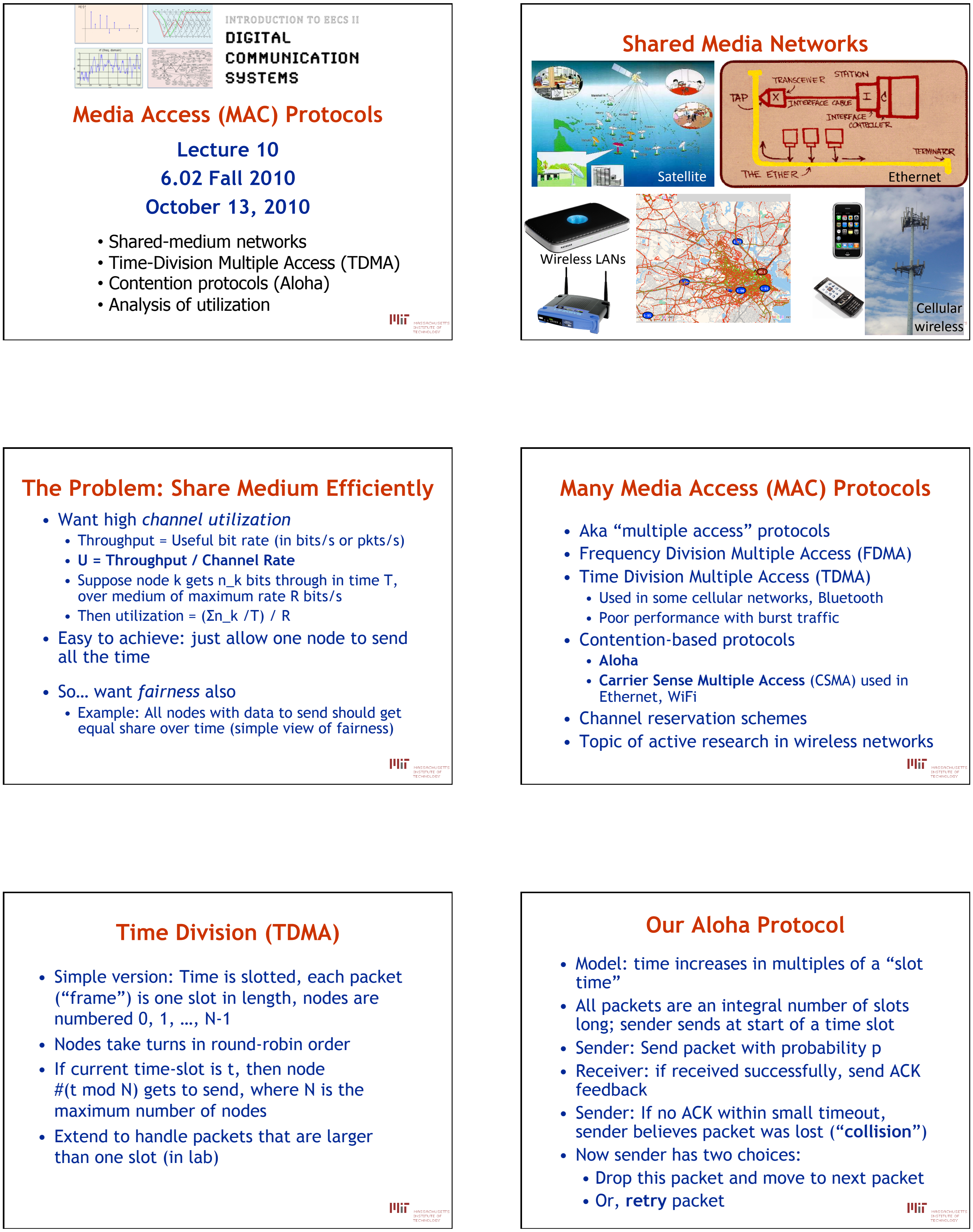
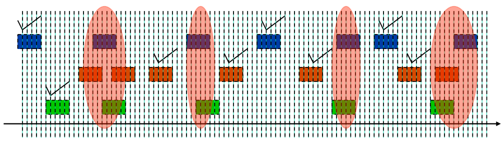


INTRODUCTION TO EECS II
DIGITAL
COMMUNICATION
SYSTEMS
Media Access (MAC) Protocols
Lecture 10
6.02 Fall 2010
October 13, 2010
• Shared-medium networks
• Time-Division Multiple Access (TDMA)
• Contention protocols (Aloha)
• Analysis of utilization
Shared Media Networks
Satellite
TRANSCEIVER
STATION
TAP
INTERFACE CABLE
INTERFACE CONTROLLER
TERMINATOR
THE ETHER
Ethernet
Wireless LANs
Cellular wireless
The Problem: Share Medium Efficiently
• Want high channel utilization
• Throughput = Useful bit rate (in bits/s or pkts/s)
• U = Throughput / Channel Rate
• Suppose node k gets n_k bits through in time T, over medium of maximum rate R bits/s
• Then utilization = (Σn_k /T) / R
• Easy to achieve: just allow one node to send all the time
• So… want fairness also
• Example: All nodes with data to send should get equal share over time (simple view of fairness)
Many Media Access (MAC) Protocols
• Aka “multiple access” protocols
• Frequency Division Multiple Access (FDMA)
• Time Division Multiple Access (TDMA)
• Used in some cellular networks, Bluetooth
• Poor performance with burst traffic
• Contention-based protocols
• Aloha
• Carrier Sense Multiple Access (CSMA) used in Ethernet, WiFi
• Channel reservation schemes
• Topic of active research in wireless networks
Time Division (TDMA)
• Simple version: Time is slotted, each packet (“frame”) is one slot in length, nodes are numbered 0, 1, …, N-1
• Nodes take turns in round-robin order
• If current time-slot is t, then node #(t mod N) gets to send, where N is the maximum number of nodes
• Extend to handle packets that are larger than one slot (in lab)
Our Aloha Protocol
• Model: time increases in multiples of a “slot time”
• All packets are an integral number of slots long; sender sends at start of a time slot
• Sender: Send packet with probability p
• Receiver: if received successfully, send ACK feedback
• Sender: If no ACK within small timeout, sender believes packet was lost (“collision”)
• Now sender has two choices:
• Drop this packet and move to next packet
• Or, retry packet

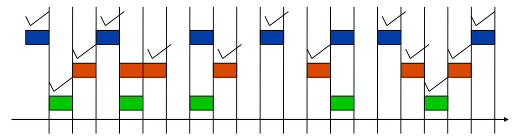
Aloha in Pictures: Collisions



Collisions! Packet is 5 slots long in this picture

- A *collision* occurs when multiple transmissions overlap in time (even partially)
- Throughput = *Uncollided* packets per second
- Utilization = Throughput / Channel Rate

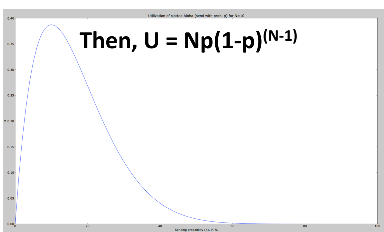
Slotted Aloha
Each Packet is Exactly One Time Slot Long



- Throughput = *Uncollided* packets per second
- Utilization = Throughput / Channel Rate

Utilization of Slotted Aloha

- Each packet = 1 slot
- Note: Node sends packets only at slot boundaries
- N **backlogged** nodes (nodes with data)



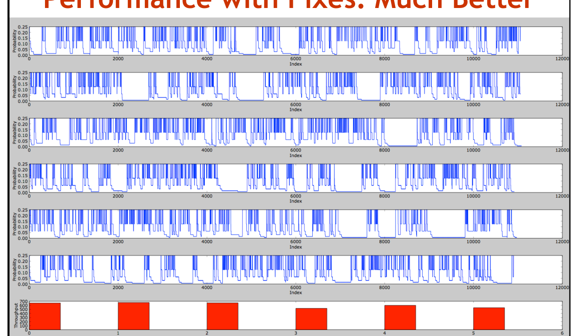
Stabilization: Selecting the right p

- Use absence of ACK from receiver as hint that collision has occurred
- If pkt lost, decrease p
  Multiplicative decrease: p ← p/2
  Binary Exponential Backoff
- If pkt received, increase p
  p ←2*p
- Such increase/decrease thinking used widely distributed network protocols
- How well does it work?

Performance: Severely Unfair!

Y-axis is per-node transmission probability
Bottom panel: per-node throughput

Performance with Fixes: Much Better



Y-axis is per-node transmission probability
Bottom panel: per-node throughput