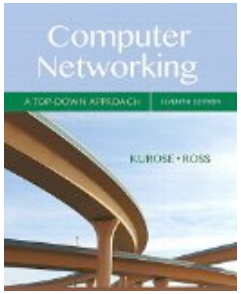
COMP 375: Lecture 36



- **News & Notes:**
  - Project #5 due Wednesday
  - Quiz #9 in class Friday
- **Reading (Wed, May 2)**
  - Sections 6.4.{0-2}

Chapter 6

THE LINK LAYER

The Link Layer provides three basic functions.

1. **Framing**: Dividing data into pieces that are sized for the network to handle.

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1. **Framing**: Dividing data into pieces that are sized for the network to handle.

- Data pieces:
  - Transport: Segments
  - Network: Datagrams (or packets)
  - Link: Frames
  - Physical: Bits

Why do we put a limit on the size of a frame?

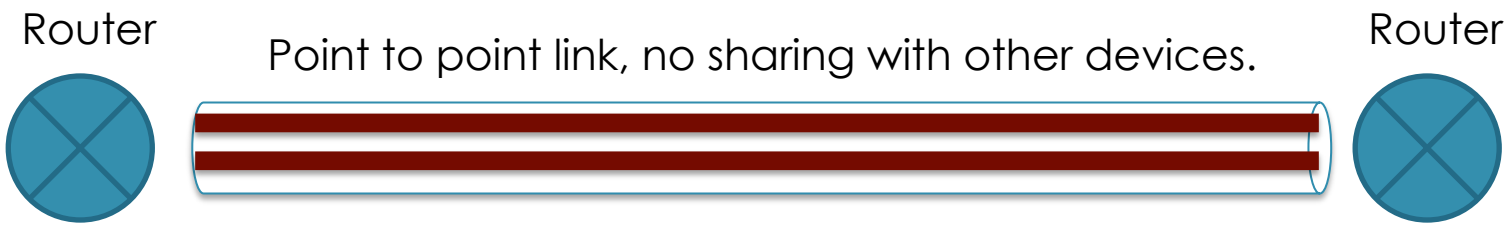
A.	To keep one user from hogging the physical channel.
B.	To make it easier to determine when a frame ends.
C.	Smaller frames have less overhead, so they have higher performance.
D.	Some other reason.

The Link Layer also needs to mediate link access.

1. **Framing**: Dividing data into pieces that are sized for the network to handle.

2. **Link access:** Determining how to share the medium, who gets to send, and for how long.

Some links may not require much in terms of coordinating access…



- **Example 1:** Single copper wire, only one of them can send at a time.
- **Example 2:** Two copper wires in cable, each can send on one simultaneously.

… but for some links this is a huge challenge!

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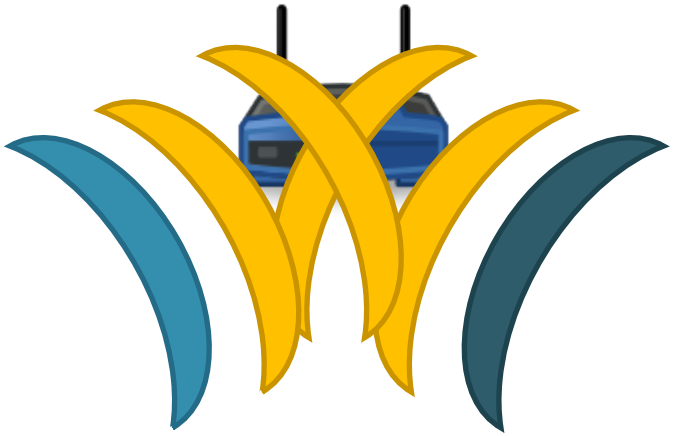
Collision!



How should we handle collisions in general?

Consider WiFi and other link media.

A.	Enforce at the end hosts that only one sender transmit at a time.
B.	Enforce in the network that only one sender transmit at a time.
C.	Detect collisions and retransmit later.
D.	Something else.

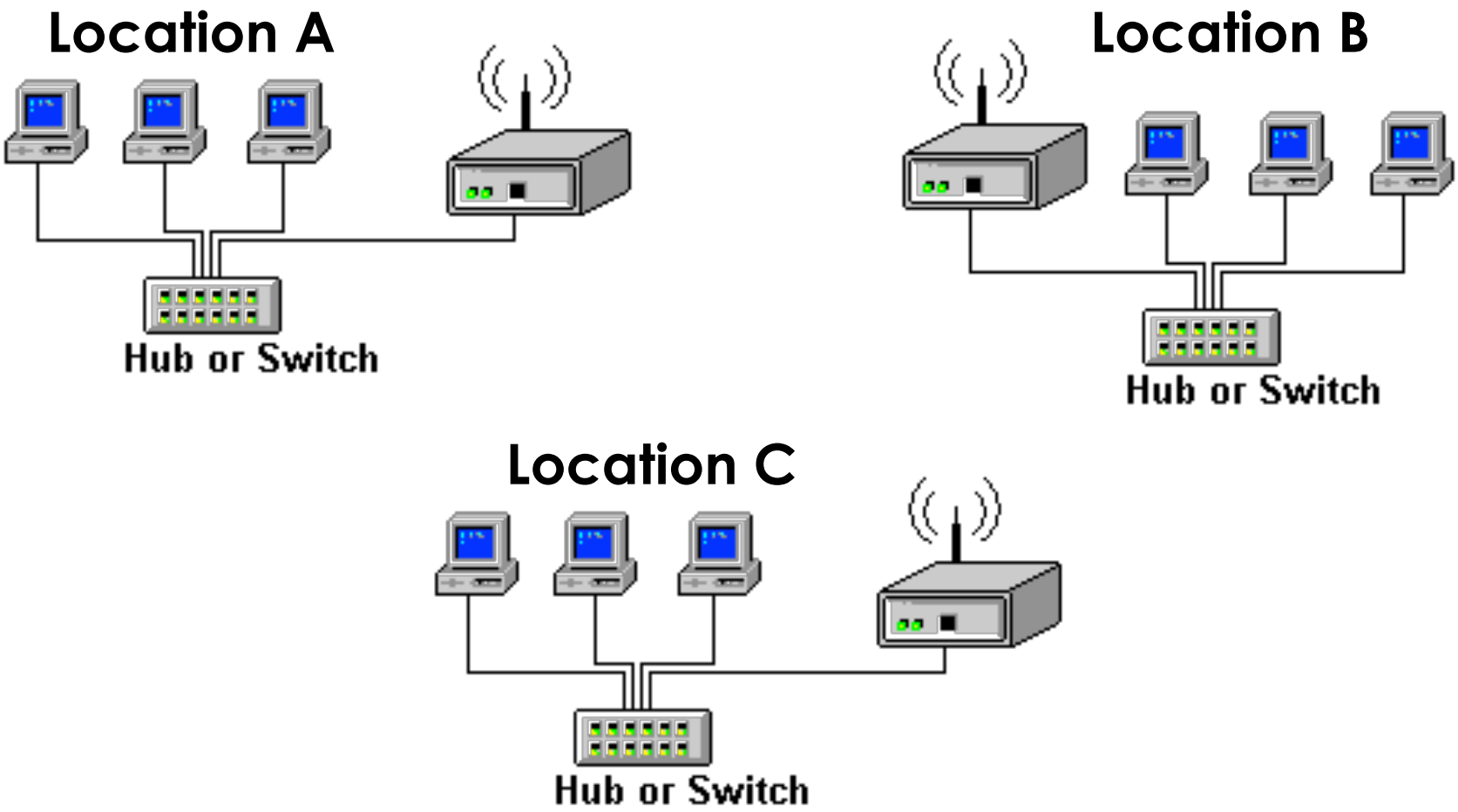
The Link Layer also provides error detection/correction.

1. **Framing**: Dividing data into pieces that are sized for the network to handle.
2. **Link access**: Determining how to share the medium, who gets to send, and for how long.
3. **E**rror detection/correction and reliability.

Section 6.3

MEDIA ACCESS

Both Point-to-Point (P2P) and Broadcast links/channels are common today.



Broadcast channels require a **multiple access protocol** to manage collisions.

Our multiple access protocol should…

1. Determine how nodes share the channel
2. Dictate when nodes can send data over the channel
3. Coordinate using the the channel itself

Given a broadcast channel of rate *R* bps, an ideal protocol has 4 properties.

1. If only one node wants to transmit, it can send at rate R.
2. When M nodes want to transmit, each can send at average rate R/M (fairness)
3. Fully decentralized:
   - no synchronization of clocks, slots
   - no special node to coordinate transmissions
4. Simple

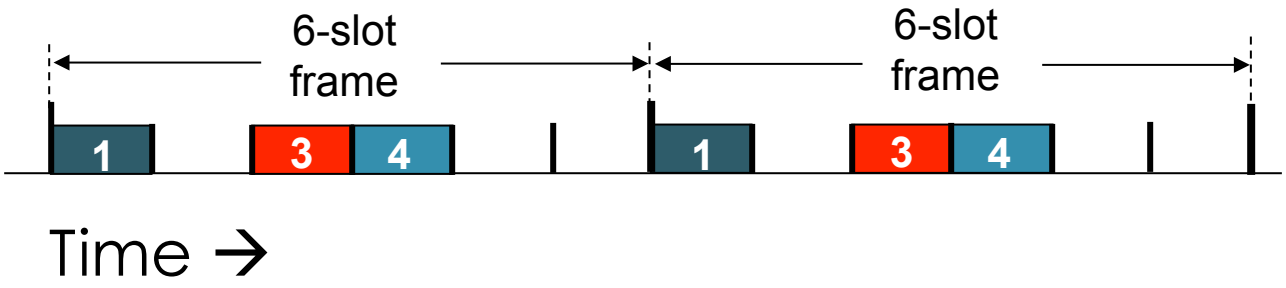
What protocols do we use for conversation?

Media access control protocols use one of three general strategies.

1. Channel partitioning
2. Random access
3. Taking turns

TDMA* gives each node a fixed amount of time, then does round-robin.

- *Example*: Channel with 6 nodes
  - Nodes 1, 3, and 4 have frames to send
  - Nodes 2, 5, and 6 are idle



*TDMA: Time Division Multiple Access

FDMA divides channel into several frequency bands, each node gets one.

- *Example*: Channel with 6 nodes
  - Nodes 1, 3, and 4 have frames to send
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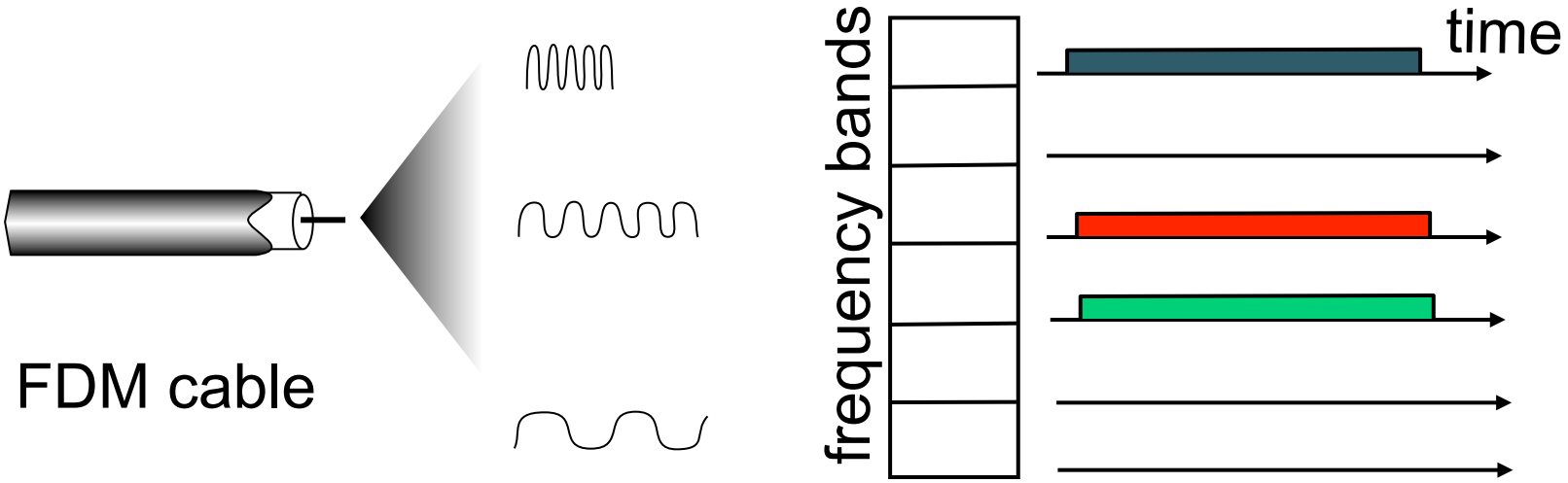


FDMA: Frequency Division Multiple Access*

How many of our desired properties does ***channel partitioning*** give us?

1. If only one node wants to transmit, it can send at rate R.

2. When M nodes want to transmit, each can send at average rate R/M (fairness)

3. Fully decentralized:

- no synchronization of clocks, slots
- no special node to coordinate transmissions

4. Simple

A.	0
B.	1
C.	2
D.	3
E.	4

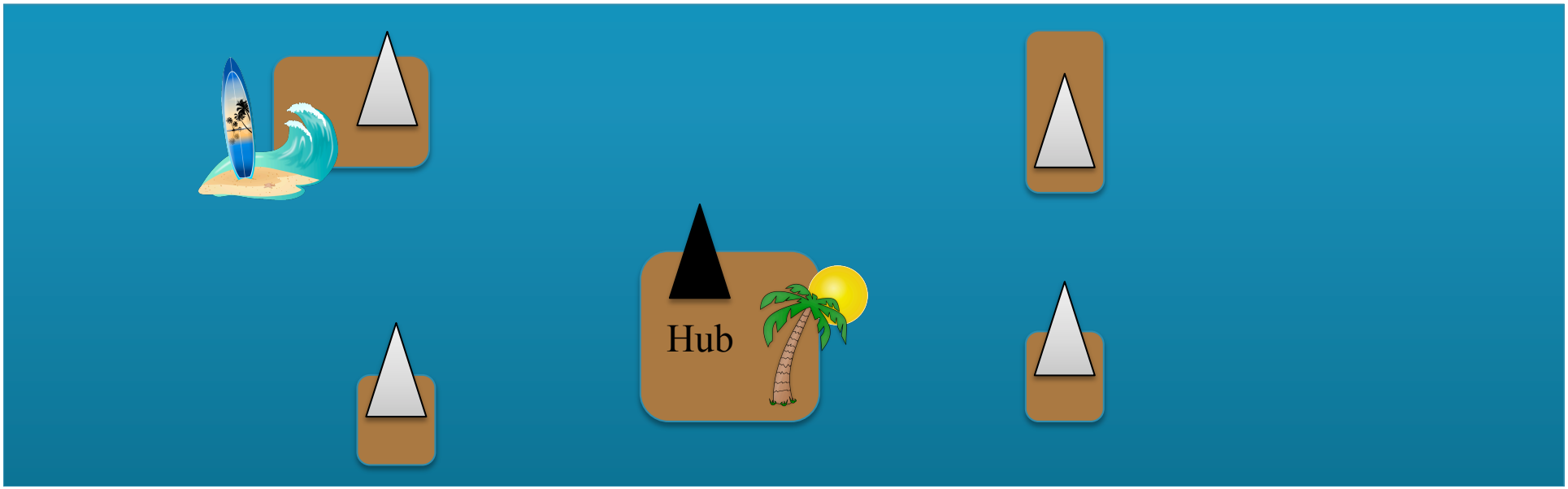
Channel partitioning is widely used, in both wired and wireless channels.

1. Terrestrial radio (frequency division)
2. Satellite (frequency division)
3. Fiber optic links (wavelength division)
4. Cell phones
   - 2G (time division)
   - 3G (code division)
   - 4G (frequency division)

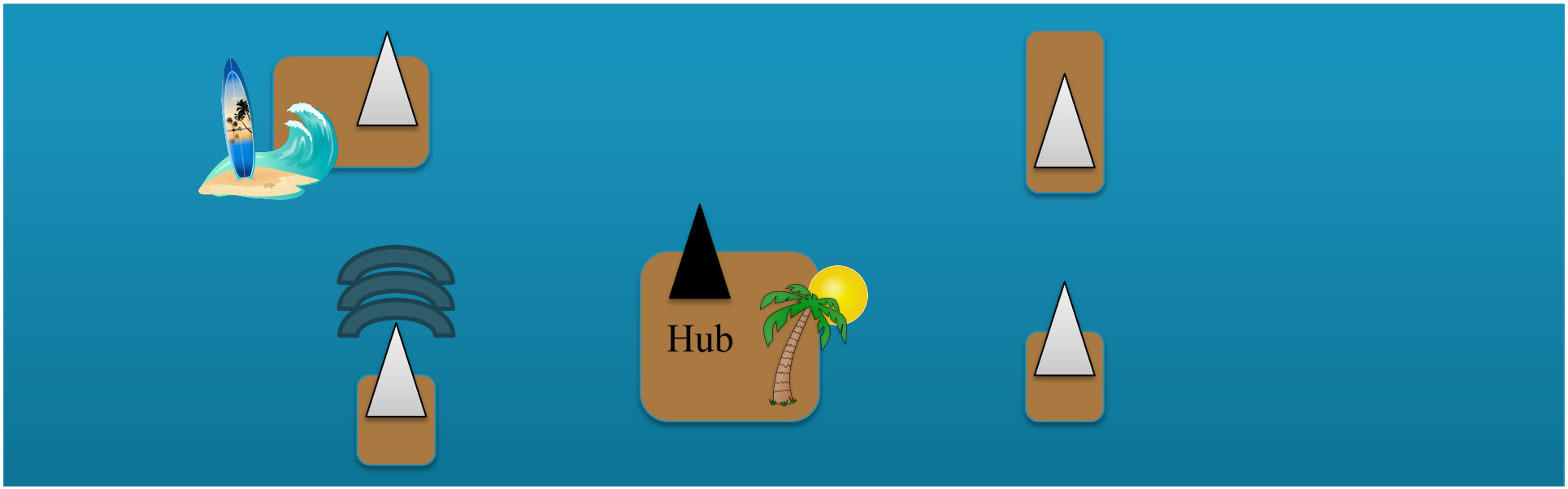
In Random Access Protocols there is no a priori coordination among nodes.

- **Random access MAC protocol** specifies:
  - How to minimize collisions
  - How to detect collisions
  - How to recover from collisions

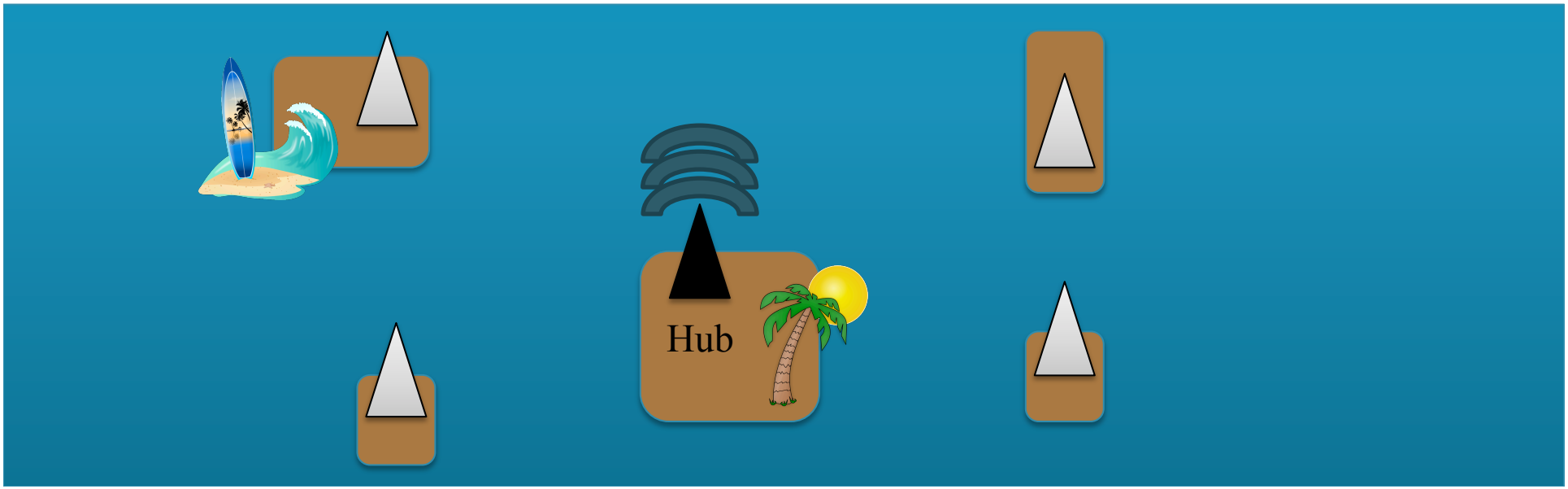
ALOHAnet created a network between islands using radio communication.



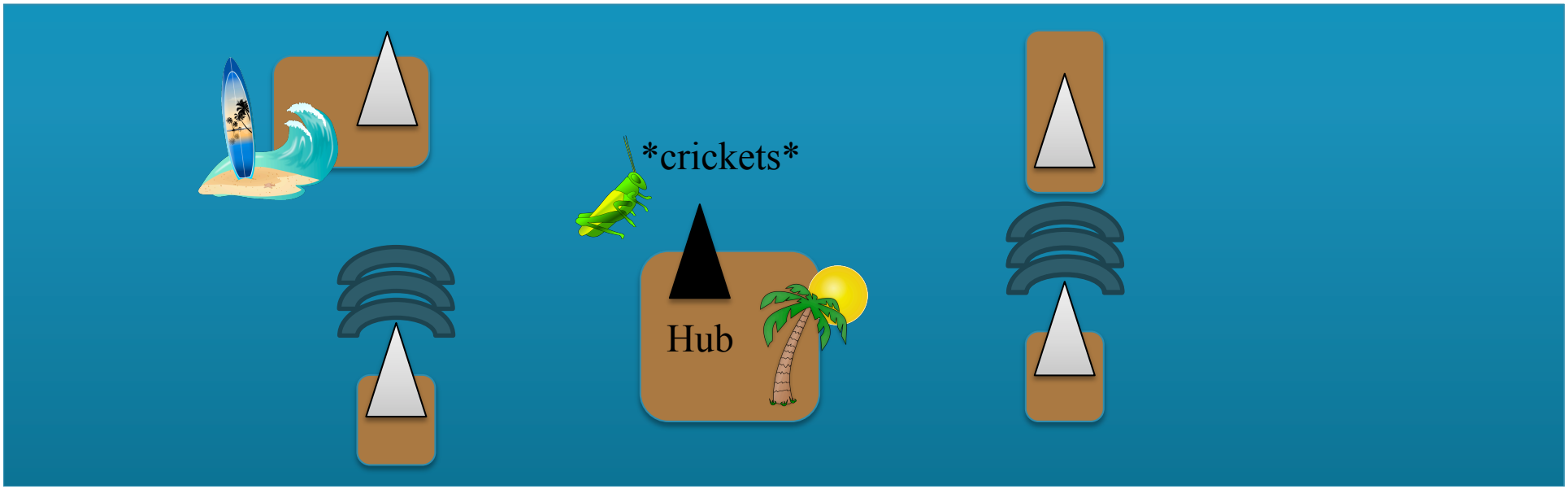
If user gives you data, send it all *immediately*!



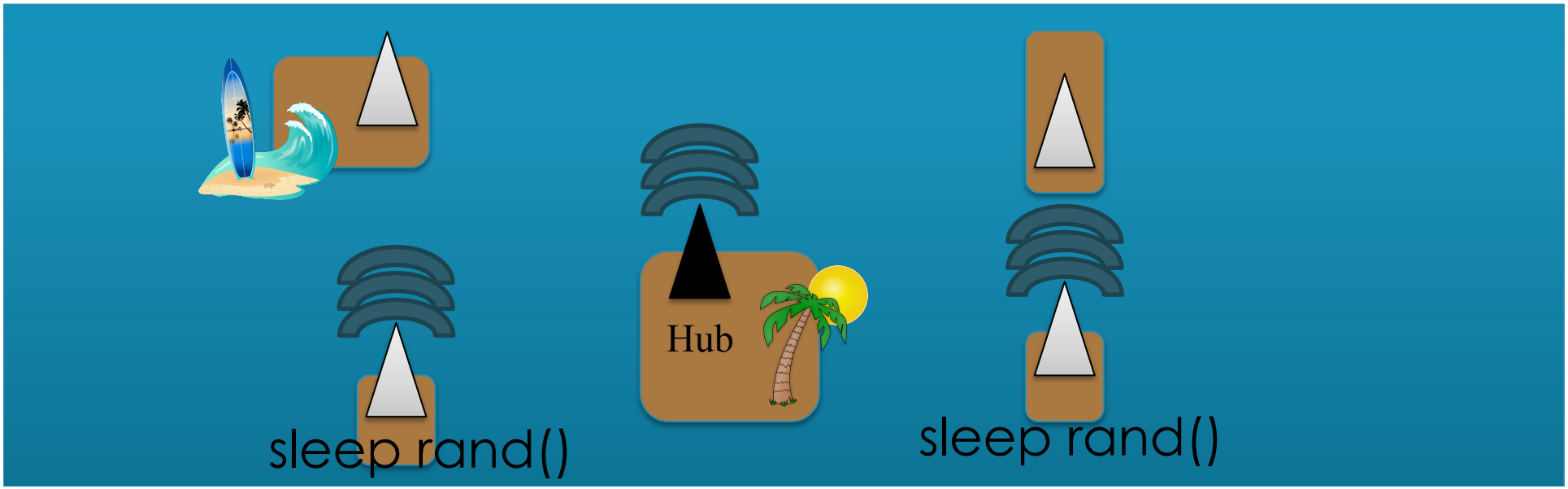
If the hub received everything, it sends an ACK.



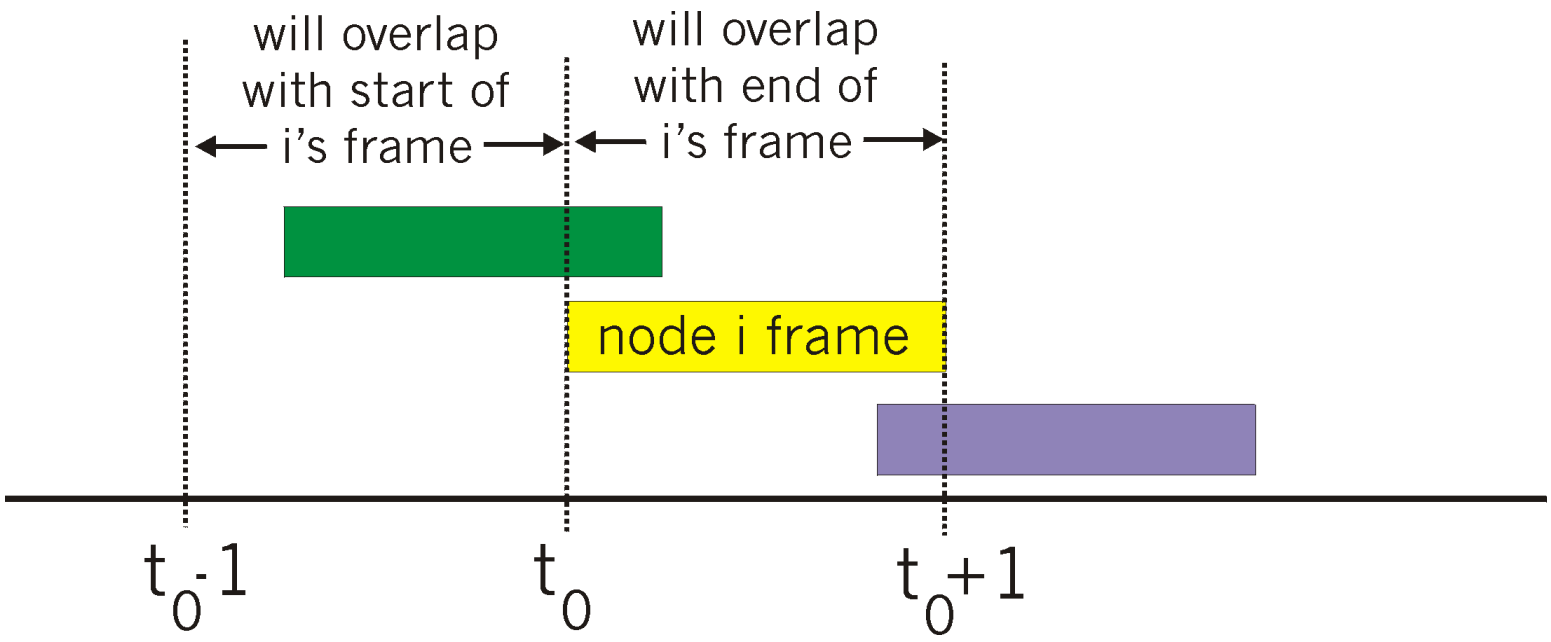
If senders collides, hub doesn't ACK...



If sender doesn't receive an ACK, it waits a random time and tries to send again.



ALOHAnet is decentralized, but poor transmission rate because of collisions.



Any other transmissions starting between t_0-1 and t_0+1 will result in a collision. Only 18% efficiency!