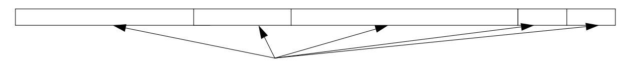
CSE and EE 461
Lecture 16

Spring Quarter 1998

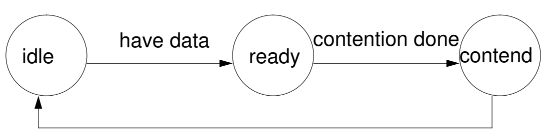
Binary Tree Protocol

- An alternative to binary exponential backoff - works well in light loads and is more fair in heavy loads.



- A contention interval begins when the last contention interval ended and more than one station attempts to transmit.
- A contention interval ends when all the stations which entered the interval have completed their transmissions.
- Stations that arrive during a contention interval must wait until the end of the current contention interval before they can begin transmitting.
- Not 1-persistent, but under light loads binary tree is like a 1-persistent protocol

Binary Tree Protocol Strategy



Binary Tree Protocol

- contend

  transmit

  If success then go to "idle" state

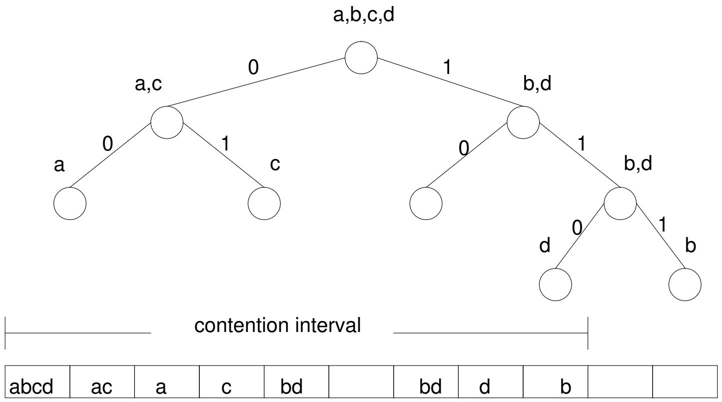
  else {collision}

  flip a 0-1 coin

  if 0 then call contend

  if 1 then wait until 0-flippers are done then call contend

Example of Binary Tree Protocol



Implementing the Binary Tree Protocol

- g - local counter at each station

  g = 0 implies that no contention interval in progress and channel is free

  g > 0 implies at least g stations are contending

  feedback from channel

  empty slot = 0

  transmission = 1

  collision = 2

- Invariant g = number of leaves in tree expanded so far.

Calculation of g

	2	0,1
g = 0	g := 2	g := 0
g > 0	g := g+1	g := g -1

Implementation Continued

- Each processor which is involved in a contention keep a local variable d

  d = 0 implies that the station is free to transmit

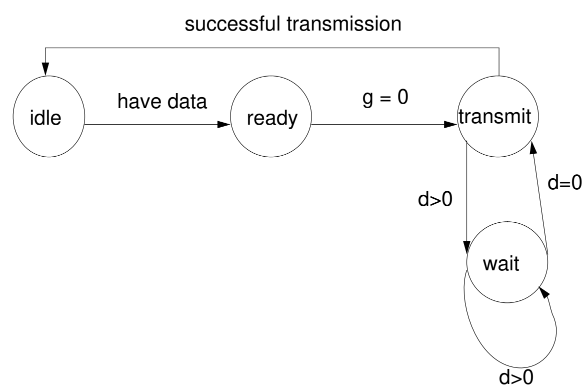
  d > 0 implies that the station must wait before tranmitting

  Invariant: d = the number of number of leaves in the subtree of my sibling.

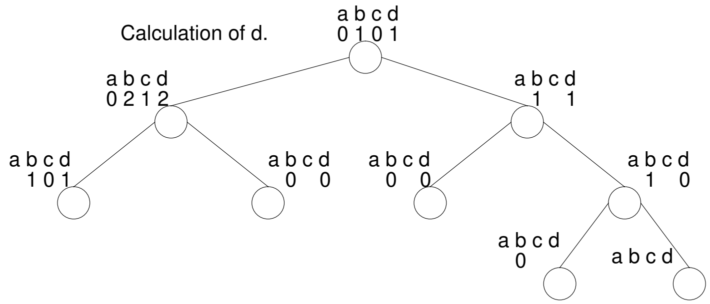
Calculation of d

	2	1	0
d = 0	d:=0 .5 d:=1 .5	go to idle	impossi-ble
d > 0	d:=d+1	d:=d-1	d:=d-1

State Transitions Expanded



Return to Example



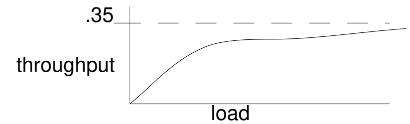
calculation of g

abcd	ac	a	c	bd		bd	d	b		

0 2 3 2 1 2 1 2 1 0

Properties of the Binary Tree Protocol

- In light loads behaves like a 1-persitent protocol
- Fair - only those involved in a contention interval will transmit during that contention interval.
- In heavy loads - the utilization (throughput) is not as good as it should be. It is only about 0.35, that is about 35% of the channel capacity has useful transmissions. Throughput does not go to zero as the load goes to infinity.



- There are modifications to improve the utilization in heavy loads to about 0.47

A Little Analysis

- Let E(k) be the expected time to resolve a contention interval with k contenders.

  E(1) = 1

  E(2) = 1 + 1/2(E(1) + E(1)) + 1/2(1 + E(2))

  = 5/2 + 1/2E(2)

  Thus, E(2) = 5

  Generally, for k > 1 and assumming that E(0) = 1 we have:

$$E(k) = 1 + \frac{1}{2^k} \cdot \sum_{i=0}^{k} \binom{k}{i} (E(i) + E(k-i))$$