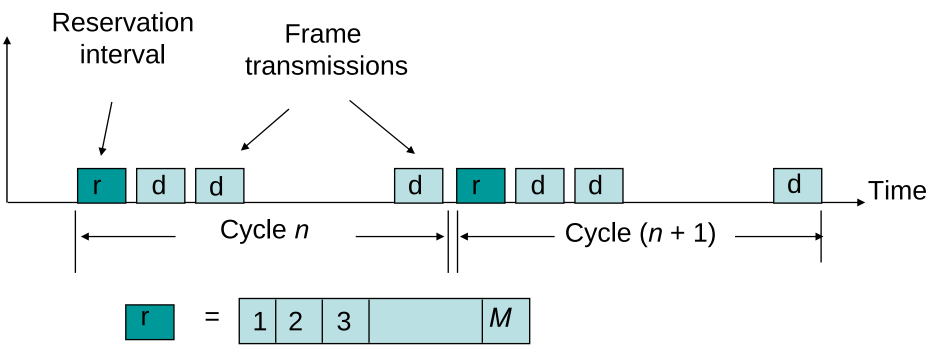
6.3 Scheduling Approaches
6.3.1 Reservation systems

a. time is divided into cycles with variable length
b. each cycle begins with a reservation interval
c. reservation interval: M mini slots, one mini slot per station
d. a station uses its mini-slot to indicate whether it has a frame to transmit or not
e. the length of a cycle corresponds to the number of stations that have a frame to transmit.
(Fig 6.19)



6.3.1 Reservation systems

- Maximum attainable throughput:
  - Assume: 1. Frame transmission time $X=1$ time unit
    2. a reservation mini slot: V time units ($V<1$)
  - Each frame transmission requires $1+V$ time units
    $\therefore$ $\rho_{max} = \frac{1}{1+V}$ for one frame reservation/mini-slot
    $V = 5\%, \rho_{max} = 95\%$
  - If one mini slot can reserve up to k frames, the maximum cycle size is $MV+MK$ time units, which transmits MK frames.

$$\rho_{max} = \frac{MK}{MV+MK} = \frac{1}{1+\frac{V}{K}}$$

for K frame reservation/mini-slot

Reservation systems

- Disadvantages: overhead (MV time units) is fixed, no matter there are frames to be transmitted or not.
  If M is large, and stations transmit frames infrequently the system is inefficient
- Solution: not allocation a mini-slot for each station.
  Stations contend for a reservation mini-slot by using random access technique such as slotted ALOH.
  If slotted ALOHA, each successful reservation requires
  $\frac{1}{0.368}$=2.71 mini slots on average.
  $\rho_{max} = \frac{1}{1+2.71V}$
  V=5% ρ_{max}=88%

  GPRS (General Packet Radio Service) use a reservation protocol with slotted ALOHA to provide data service over GSM networks.

6.3.2 Polling

a. Stations take turns accessing the medium
b. At any given time, only one station has the right to transmit
c. When a station is done transmission, it passes the right to the next station

- Examples: *Fig 6.21a*, *Fig 6.21b*

  A central controller polls the station in round-robin fashion or according to some other pre-determined order.

  Fig 6.21c (without a central controller)

  When a station is done transmitting, it is responsible for sending a polling message to the next station.

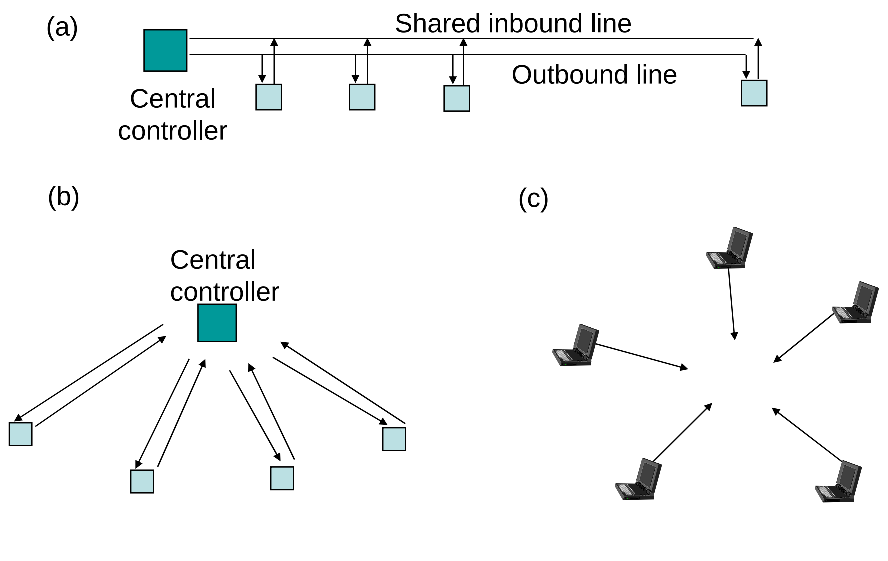


Figure 6.21

6.3.2 Polling (continue)

- Performance analysis
  1) a station is allowed to transmit as long as it has information in its buffer.
     - Walk time t': time elapse from the first bit of a polling message is transmitted to the next station begins transmission.
     - Total walk time τ': the sum of the walk times in one cycle (over head of a polling system)

       $\tau' = Mt'$, M: number of stations. see *Fig 6.22*
     - Cycle time T_c: total time that elapses between the start of two consecutive polls of the same station = M walk time + M station transmission times
     - Let:

       $\frac{\lambda}{M}$: average frame arrival rate from a station (frames/sec)

       $E[N_c]$: avg number of frame arrivals to a station in one cycle time

       $E[N_c] = \frac{\lambda}{M} \cdot E[T_c]$

       X : frame transmission time

6.3.2 Polling (continue)

Then:

$$E[T_c] = M\{E[N_c]X+t'\}=M\{ \frac{\lambda}{M} E[T_c]X+t'\}$$

$$\Rightarrow \quad E[T_c] = \frac{Mt'}{1-\lambda X} = \frac{\tau'}{1-\rho}$$

$\rho = \lambda X$ is the load,

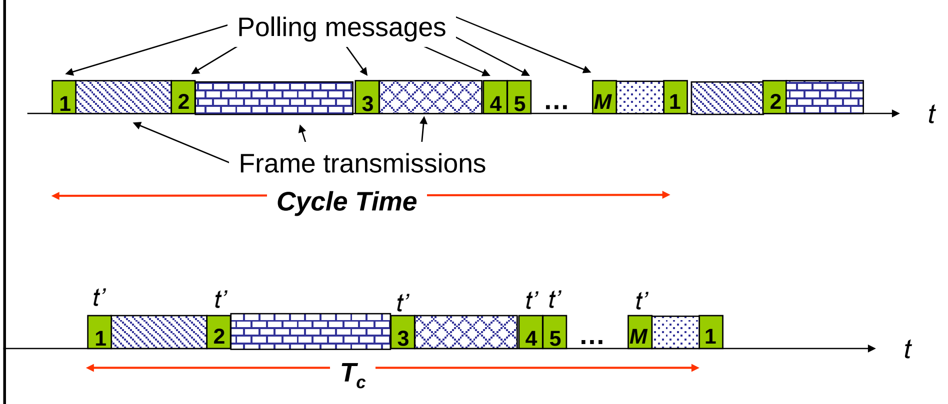
$E[T_c] \approx$ *frame delay*

ρ small, $E[T_c] \approx \tau'$.

$\rho \to 1$, $E[T_c] \to \infty$. delay unbounded

high throughput (ρ close to 1) can be achieved at the cost of large delay

What if $\lambda X > 1$? Not a stable system.



6.3.2 Polling (continue)

2) The time that a station is allowed to transmit per poll is limited
   - Example: one frame transmission per poll

     Maximum $T_c = MX + \tau'$.

     $\rho_{max} = \frac{MX}{MX+\tau'} = \frac{1}{1+\frac{\tau'}{MX}} < 1$

     ρ_{max} <1, but delay is bounded