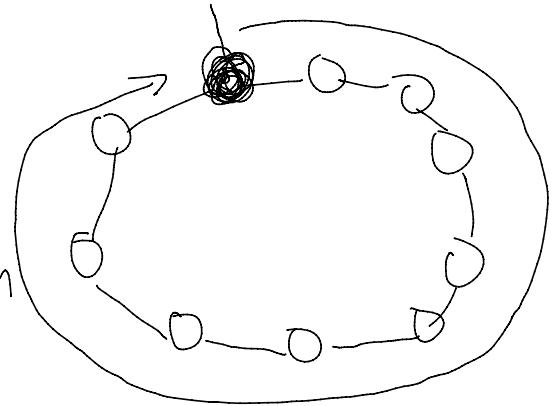


$N$  nodes, bandwidth  $R$   
 packet size  $L$ , propagation  
 delay  $t$



① Only one node transmits:

$$TP = \frac{L}{\frac{L}{R} + Nt + \underbrace{N \cdot \frac{L_0}{R}}_{\text{small}}} = \frac{L}{\frac{L}{R} + Nt} = R \cdot \frac{L}{R(\frac{L}{R} + Nt)} = R \cdot \frac{L}{L + N \cdot t \cdot R} < R$$

$t \uparrow$   $TP, \downarrow$   
 $N \uparrow$   
 $R \downarrow$

if  $R \uparrow$   $TP, \uparrow$  but  $\frac{TP}{R} \downarrow$

②  $M$  nodes transmit:

$$TP_M = \frac{1}{M} \cdot \frac{ML}{M \cdot \frac{L}{R} + Nt} = \frac{R}{M} \cdot \frac{ML}{R(M \cdot \frac{L}{R} + Nt)}$$

$$= \frac{R}{M} \cdot \frac{ML}{ML + R \cdot Nt} = \frac{R}{M} \cdot \left( \frac{L}{L + \frac{R \cdot Nt}{M}} \right)$$

$$\boxed{\begin{array}{cc} \ell \uparrow & TP_m \downarrow \\ N \uparrow & \end{array}}$$

$$M \uparrow$$

$$\frac{TP_m}{R/M}$$

$$R \uparrow$$

$$\frac{TP_m}{R/M}$$



$$\leq \frac{R}{M}$$