March 29, 2012 EE 597

Last class:

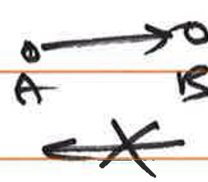
ETX metric:

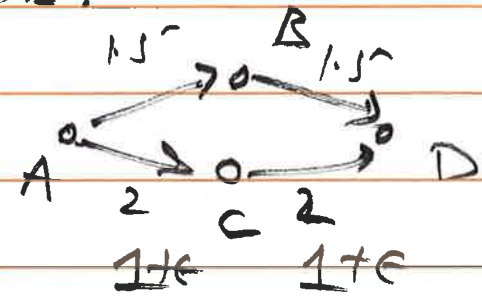
expected # of transmissions on a link (w/ ARQ) till successful delivery

$$\widehat{ETX}_{ij}(t) = \alpha\, \widehat{ETX}_{ij}(t-1) + (1-\alpha)\, ETX_{ij}^{inst}(t)$$

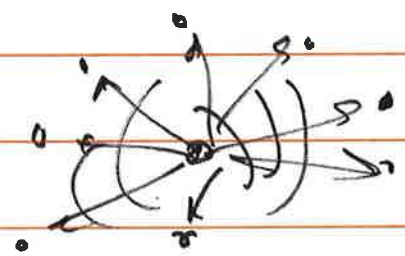
this calculation can be done locally at node i for all possible neighbors j that it sends packets to.

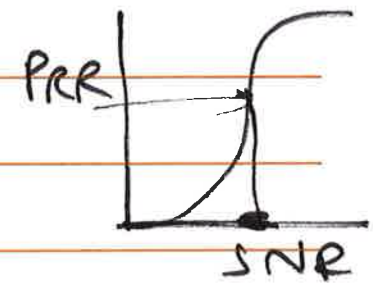
these could be control (beacon) packets or data packets.



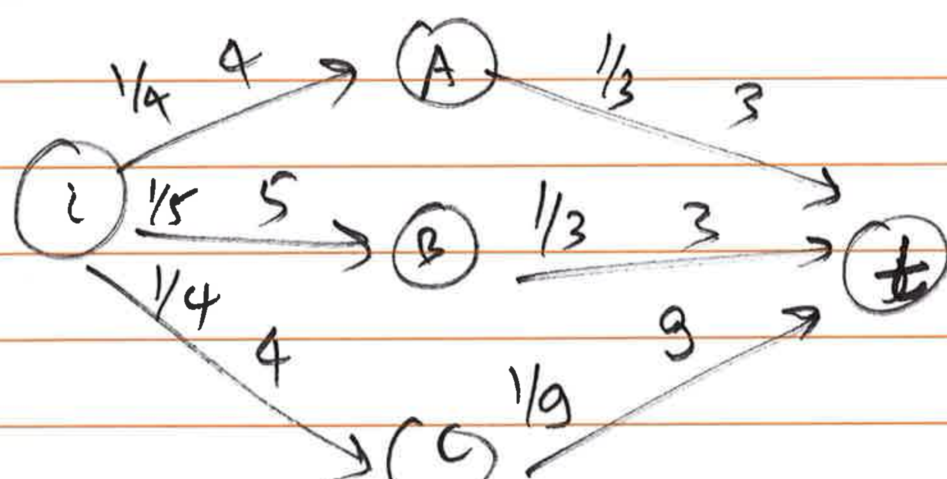


alternative implementation: each node periodically broadcasts sequential beacons to its neighbors w/ sequence numbers. Use this to estimate PRR



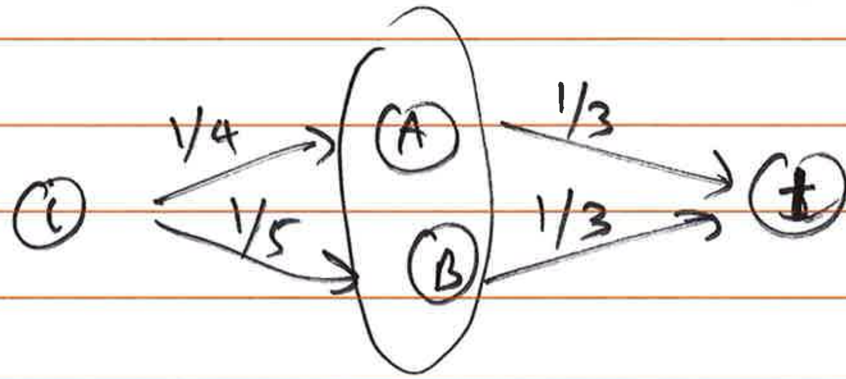


Anypath Routing.



$$i \xrightarrow{4} A \xrightarrow{3} t$$

$ETX = 7.$



$$d_{i,J} = \frac{1}{p_{iJ}} \qquad J = \{A, B\}$$

$$p_{i,J} = 1 - \left(1-\tfrac{1}{4}\right)\left(1-\tfrac{1}{5}\right)$$

$$1 - \frac{3}{\cancel{4}} \cdot \frac{\cancel{4}}{5}$$

$$= 2/5$$

$$d_{i,J} = 5/2 = 2.5$$

$$\omega_A = \frac{1/4}{2/5} = \frac{5}{8} \quad D_A = 3$$

$$\omega_B = \frac{1/\cancel{8} \cdot 3/4}{2/\cancel{5}} = \frac{3}{8} \quad D_B = 3$$

$$D_{J\cancel{L}} = 3$$

$$ETX_{(\{A,B\}=J)} = 2.5 + 3 = 5.5$$

$$J = \{A, B, C\}$$

$$p_{iJ} = 1 - (1 - 1/4)(1 - 1/5)(1 - 1/4)$$

$$= 1 - \frac{3}{\cancel{4}} \cdot \frac{\cancel{4}}{5} \cdot \frac{3}{4} = \frac{11}{20}$$

$$D_{iJ} = 20/11 \sim 2.$$

D_j :

$$w_A = \frac{1/4}{11/20} = \frac{5}{11} \qquad 3$$

$$w_B = \frac{1/5 \cdot 3/4}{11/20} = \frac{3}{11} \qquad 3$$

$$w_C = 3/11 \qquad 9.$$

$$D_{Jt} = \frac{15}{11} + \frac{9}{11} + \frac{27}{11}$$

$$= \frac{51}{11}$$

total ETX $\quad i - \underbrace{\{A, B, C\}}_{J} - t$

$$\frac{51}{11} + \frac{20}{11} = \frac{71}{11} \sim 6.45$$

given $G = (V, E)$

goal: compute the shortest anypath from all nodes in the network to a given destination d.

nodes $i \in V$ • ~~have~~ maintain & update a bound D_i on the shortest anypath cost to d.

• maintain & update a forwarding set F_i which stores the receiver set for node i

• two data structures S & Q

nodes w/ shortest anypath defined already

$V \setminus S$

keyed by D_i value

for each $i \in V$

  do $D_i \leftarrow \infty$

    $F_i \leftarrow \phi$

  $D_d \leftarrow 0$

  $S \leftarrow \phi$ $Q \leftarrow V$

While $Q \neq \phi$

  do $j \leftarrow$ EXTRACT-MIN (Q)

    $S \leftarrow S \cup \{j\}$

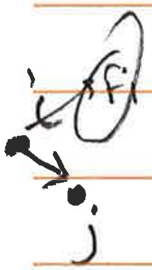
    for each incoming edge $(i, j) \in E$

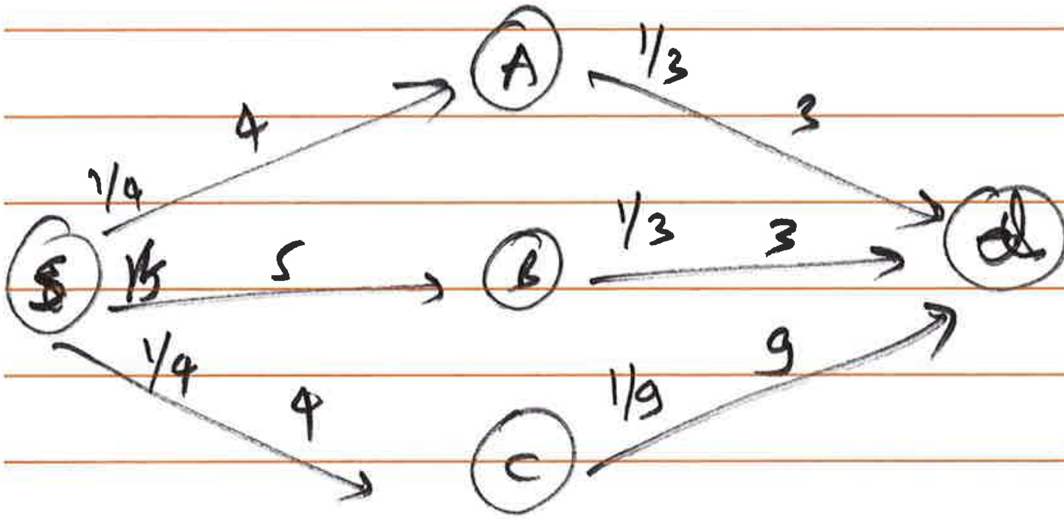
      do $J \leftarrow F_i \cup \{j\}$

      if $D_i > D_J$

        then $D_i \leftarrow d_{iJ} + D_J$

          $F_i \leftarrow J$





	S	A	B	C	d
D_i:	∞	3	3	9	0
F_i =	{ }	{d}	{d}	{d}	{ }

$Q = \{ A, A, B, C, \}$ ~~S = {d}~~

$S = \{d\}$

j : d

consider A first $J = \{d\}$

$D_A = 3,$

	s	A	B	C	d
D_i	7	3	3	9	0
F_i	$\{A\}$	$\{d\}$	$\{d\}$	$\{d\}$	$\{\}$

$Q = \{\cancel{s}, \cancel{A}, B, C\}$ $\qquad S = \{d, A\}$

$j : A$

$D_s = 7 \qquad F_s \leftarrow \{A\}$

now, extract B : consider $i = s$

$$J = F_i \cup \{i\} = \{A, B\}$$

$$D_s \leftarrow d_{iJ} + D_J$$
$$= 5.5$$

$$F_s \leftarrow J = \{A, B\}$$

	s	A	B	C	d
D_i	5.5	3	3	9	0
F_i	$\{A, B\}$	$\{d\}$	$\{d\}$	$\{d\}$	$\{\}$

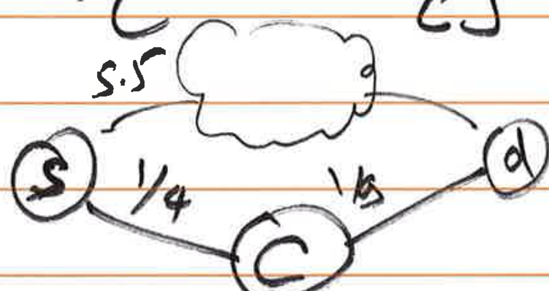
$Q = \{s, C\}$ $\qquad S = \{d, A, B\}$

extract-min Q gives s

i: C

$$J \leftarrow \{d, s\}$$

$$D_C = d_{CJ} + D_J$$



$$w_d = \frac{1/9}{1/3} = 1/3$$

$$w_s = 2/3$$

$$p_{CJ} = 1 - \frac{\cancel{8}^{\,2}}{9} \cdot \frac{3}{\cancel{4}} = 3/9 = 1/3$$

$$d_{CJ} = 3$$

$$D_J = 1/3 \cdot 0 + \frac{2}{3} \cdot 5.5 = 11/3 \sim 3.66$$

$$D_C = 6.66$$

	s	A	B	C	d
D_i	5.5	3	3	6.66	0
F_i	$\{A, B\}$	$\{d\}$	$\{d\}$	$\{d, s\}$	$\{\}$

$Q = \{C\}$ $\quad$ $S = \{d, A, B, s\}$