USC University of Southern California

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Multicast Routing using Mutual Information Accumulation (MIA)

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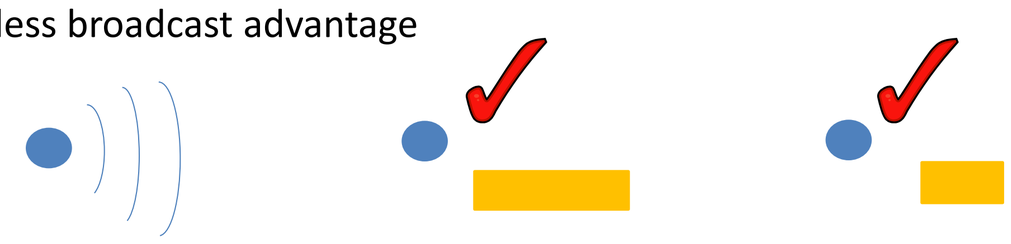
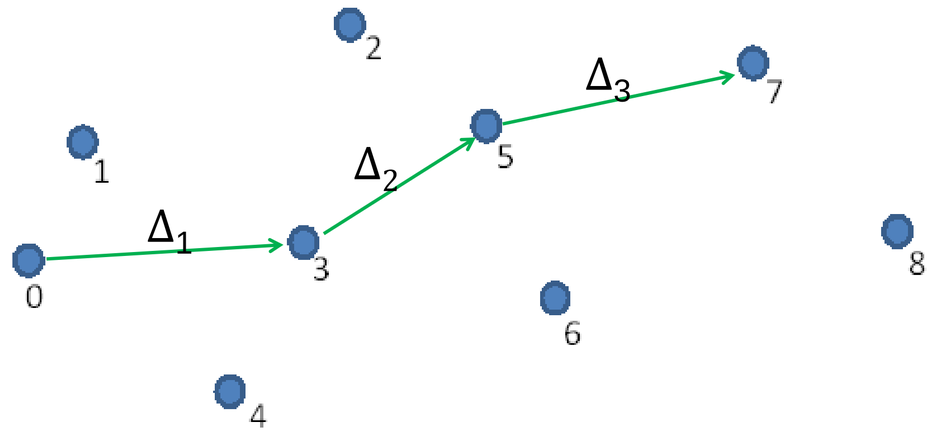
What is MIA?

- Wireless broadcast advantage



- Using rateless codes reduces delay

Routing with MIA



- Node 0 – source; Node 7 – destination
- Minimum delay routing – split into two parts
- Route Selection – an ordering of nodes from source to destination(s). E.g. : [0, 3, 5, 7]
- NP hard – resort to heuristics
- Resource Allocation – computing transmission durations for a given route
- Formulated as a linear program

$$
\begin{aligned}
&minimize && \Delta_1 + \Delta_2 + \Delta_3 \\
&subject\ to && A_{01}\, C_{03} \geq B \\
& && A_{01}\, C_{05} + A_{02}\, C_{05} + A_{32}\, C_{35} \geq B \\
& && A_{01}C_{07} + A_{02}C_{07} + A_{32}C_{37} + A_{03}C_{07} + A_{33}C_{37} + A_{53}C_{57} \geq B \\
& && A_{01} \leq \Delta_1 \\
& && A_{02} + A_{32} \leq \Delta_2 \\
& && A_{03} + A_{33} + A_{53} \leq \Delta_3 \\
& && \Delta_1, \Delta_2, \Delta_3, A_{01}, A_{02}, A_{03}, A_{32}, A_{33}, A_{53} \geq 0
\end{aligned}
$$

- C_{ij} – Channel capacity between nodes i and j
- A_{ij} – Amount of time node i is scheduled to transmit in stage j
- B - Number of bits required to decode the packet (slightly more than the length of the packet)

Multicast Performance Bounds

$$\max T_i \leq T_{multicast} \leq \min(T_i + \delta_i)$$

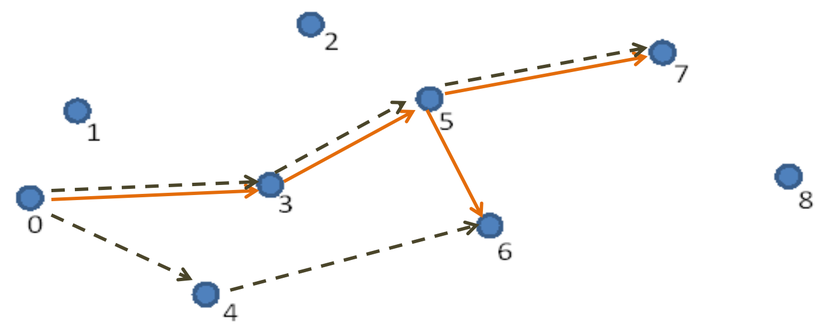
- T_i – optimal unicast delay from source to i^{th} destination
- δ_i – Extra time taken to reach remaining destinations after delivering the packet first to the i^{th} destination
- Tight inner and outer bounds

Inner Bound:

Outer Bound:

- S – source; D_1 & D_2 – destinations; d – coverage radius

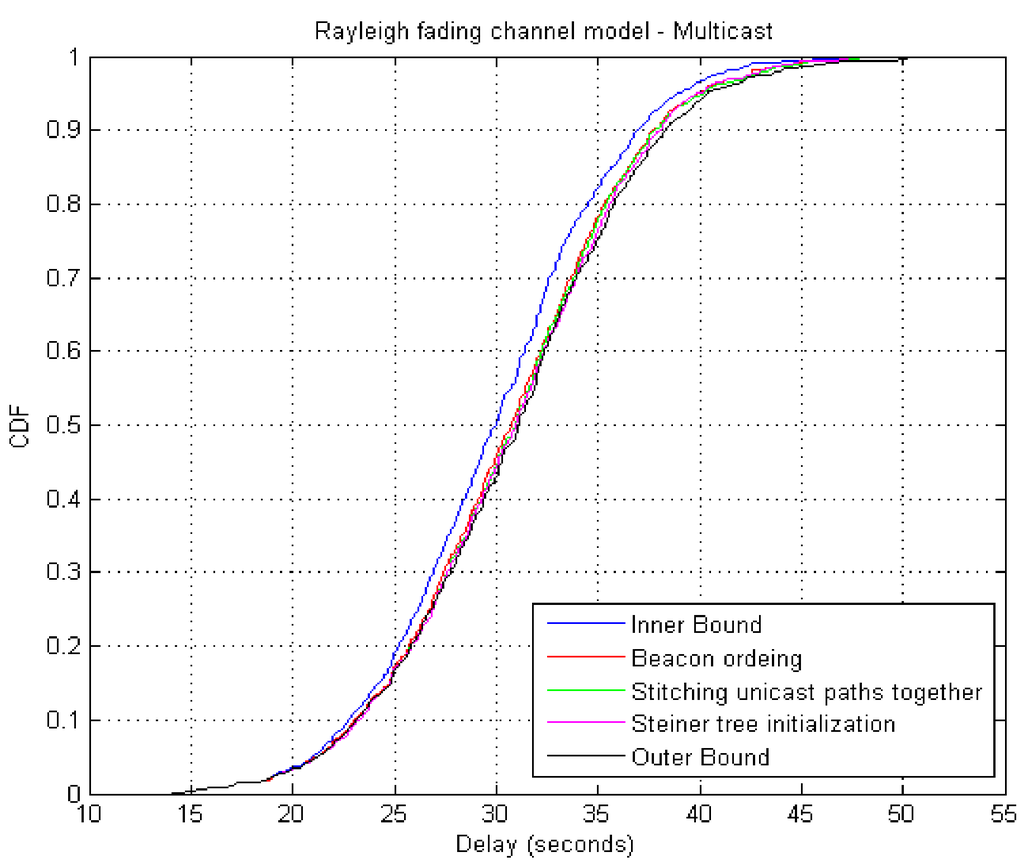
Heuristics for Route Selection



- Node 0 – source; Nodes 6 & 7 - destinations
- Beacon ordering
  - E.g. : [0, 1, 4, 3, 2, 5, 6, 7]
- Steiner Tree heuristics
  - E.g. : [0, 3, 5, 6, 7]
- Stitching unicast paths together ([0, 3, 5, 7] and [0, 4, 6])
  - E.g. : [0, 4, 3, 5, 6, 7]

Simulation Results

- Network consists of 20 nodes spread in a 3m x 3m area
- One source at (0,0); two destinations at (3,0) and (3,3)
- Other nodes uniformly distributed over the given area
- Rayleigh fading channel model
- Transmit power, $P = 1$ and noise floor, $N_0/2 = 1$ for all nodes
- 1000 different networks



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