Multiple Access Links and Protocols

Two types of "links":
- point-to-point
  - PPP for dial-up access
  - point-to-point link between Ethernet switch and host
- broadcast (shared wire or medium)
  - old-fashioned Ethernet
  - upstream HFC
  - 802.11 wireless LAN

Ideal Multiple Access Protocol

Broadcast channel of rate \( R \) bps

1. when one node wants to transmit, it can send at rate \( R \).
2. when \( M \) nodes want to transmit, each can send at average rate \( R/M \).
3. fully decentralized:
   - no special node to coordinate transmissions
   - no synchronization of clocks, slots
4. simple
   - inexpensive to implement

MAC Protocols: a taxonomy

- Channel Partitioning
  - TDMA
  - FDMA
  - CDMA
- Random Access
  - ALOHA / Slotted ALOHA
- "Taking Turns"
  - polling by a master node (e.g. Bluetooth)
  - token-passing (e.g. FDDI)


**Question from Exam (Deadline A', 2008/9)**

• Utilisation = \[ \frac{t \text{ time sending original packets}}{\text{total time sending data}} \]
• \( p_A, p_B \): probabilities for a successful transmission
• \( u_A, u_B \): channel utilizations
• Let \( X,Y \) be random variables counting how many stations transmitted in networks \( A,B \) respectively

\[ X, Y \sim B(4, p) \]

1. \( p_A = \Pr[X = 1] \Pr[Y = 0] = 4p(1 - p)^3(1 - p)^4 = 4p(1 - p)^7 \)
2. \( u_A = p_A \)
3. \( p_B, u_B \) the same (symmetry)

• \( X \sim B(4, t) \)
• \( p_A = \Pr[X = 1] = 4t(1 - t)^3 \)
• \( u_A = \frac{1}{2}p_A = 2t(1 - t)^3 \)
• \( p_B, u_B \) the same (symmetry)

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**Question from Exam (Deadline A', 2008/9)**

• The manager of network B requested more time slots. Since he was not satisfied with the result of the previous section, he increased the transmission power in his network.

\[ \Pr[X = 1] = \frac{1}{2} \Pr[Y = 0] = 4(1 - p)^7 \]

• \( u_A = p_A \)
• \( p_B, u_B \) the same (symmetry)

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**Question from Exam (Deadline A', 2008/9)**

• The manager of network A took exception to the solution of the previous section. They both moved to a TDMA network where time is divided into 8 slots, each one for a station.

\[ \Pr[X = 1] = \frac{1}{2} \Pr[Y = 0] = 4t(1 - t)^3 \]

• \( u_A = \frac{1}{2}p_A = 2t(1 - t)^3 \)
• \( p_B, u_B \) the same (symmetry)

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**Question from Exam (Deadline A', 2008/9)**

• Slotted Aloha does not work for network B. The manager of network A requested an improvement.

\[ \Pr[X = 1] = \frac{1}{2} \Pr[Y = 0] = 4t(1 - t)^3 \]

• \( u_A = \frac{1}{2}p_A = 2t(1 - t)^3 \)
• \( p_B, u_B \) the same (symmetry)