Announcements

- Lab 6 is online
- Look at the code linked from the web page
- Remember to share GitLab repository if you work with a partner
- Look for homework 5 online
- Grading plans:
  - Midterm
  - Lab 5
  - Homework 4
Today’s Plan

- A Tiny Bit of Recursion
- Analysis of Ethernet Efficiency
Make Note!
Robert Taylor, Innovator Who Shaped Modern Computing, Dies at 85

By JOHN MARKOFF  APRIL 14, 2017

Robert Taylor provided visionary leadership in the creation and development of computer networking. In 1966 he succeeded Ivan Sutherland as Director of the Information Processing Techniques Office of the Advanced Research Projects Agency (ARPA). From 1966 to 1969, he directed ARPA’s computer research program, which funded most of the U.S. computer systems research at that time. In 1966, he initiated the ARPAnet project, which laid the foundations of today’s Internet. A paper published in 1968 titled, “The Computer as a Communication Device,” with J.C.R. Licklider, laid out the future of what the Internet would eventually become.

In 1970, Taylor founded and later managed the Computer Science Laboratory at Xerox Corp.’s Palo Alto Research Center (PARC). Technologies developed in his lab included: the first networked personal computer with windowed display and graphical user interface; a network connecting the Ethernet to the ARPAnet using a forerunner to TCP/IP; the electronics and software that led to the laser printer; and “What-you-see-is-what-you-get” word-processing programs.

He also founded and managed Digital Equipment Corp.’s Systems Research Center (SRC) until his retirement in 1996. Among SRC’s projects were the first multi-threaded Unix system, the first User Interface editor, and an early high performance search engine, Alta Vista.
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An IMP provided interface between the ARPANET (the predecessor to the Internet) and a computer connected to the network. It served the same role as the modern Ethernet card (which can be purchased at Walmart for less than $25). This $82,200 IMP was one of the first made. The Honeywell 516 minicomputer inside had only 12,000 words of memory.
After breaking the news to his parents, Metcalfe phoned Bob Taylor, head of the computer science lab at PARC and his new boss. "I just failed my defense," Metcalfe told him. He was stunned by Taylor's response. "Come on anyway," Taylor said. "Finish it up out here."

Scott Kirshner, Wired Magazine, 11/01/98.
Summary of Ethernet

- Carrier Sense = Wait if network idle
- 1-persistence = If waiting, start when idle
- Collision Detection = Stop and Backoff
- Minimum packet transmission time =
  \[ 2 \times \text{max propagation time} = \text{waiting slot time} \]
- Backoff = Delay random # between 0 and \(2^{\text{failures}} - 1\) slots after collision
ETHERNET TRANSMISSION ALGORITHM

Eager to send a packet

Packet becomes ready

Transmitting packet preamble

Receiver becomes idle

Receiver not idle

Transmitting jamming signal

Waiting for backoff slots

transmitting packet contents

Receiver not idle

Receiver becomes busy

Receiver not idle

Receiver becomes idle

Preamble complete

Packet becomes ready

Reset range of delay slots to 1

= $2^0$

DONE

Double delay slot range = $2^1$ failures
Efficiency = \frac{\frac{P}{R}}{W \times T + \frac{P}{R}}

W = \frac{1 - A}{A}

A = (1 - \frac{1}{Q})(Q - 1)

P = \text{expected/average packet size}
R = \text{transmission rate (M & B call it C)}
W = \text{expected # of slots between transmissions}
T = \text{expected length of a contention slot}
A = \text{Probability exactly one computer sends in a slot}
Q = \text{number of computers trying to sent}
Efficiency = \frac{P/R}{W \times T + P/R}

\begin{align*}
P &= \text{expected/average packet size} \\
R &= \text{transmission rate (M & B call it C)} \\
W &= \text{expected \# of slots between transmissions} \\
T &= \text{expected length of a contention slot}
\end{align*}
Efficiency = \frac{\text{Time spent doing useful work}}{\text{Time spent}}
Efficiency = \frac{\text{Time spent sending}}{\text{Time spent colliding} + \text{time sending}}
Efficiency = \frac{P/R}{W \times T + P/R}

P = \text{expected/average packet size}
R = \text{transmission rate (M \& B call it C)}
W = \text{expected \# of slots between transmissions}
T = \text{expected length of a contention slot}
Let $P$ be the number of bits in an Ethernet packet. Let $C$ be the peak capacity in bits per second, carried on the Ether. Let $T$ be the time in seconds of a slot, the number of seconds it takes to detect a collision after starting a transmission. Let us assume that there are $Q$ stations continuously queued to transmit a packet; the slot duration $T$ must be long enough to allow a collision to be detected or at least twice the Ether’s round trip time.
Assume a spherical cow of uniform density.
...while ignoring the effects of gravity.
...in a vacuum.

CAN'T. BREATHE.

bastard theoretical physicists

How do you sleep at night?
Efficiency = \frac{P}{W \times T + P/R}

= \frac{1}{W \times T + \frac{P}{R}}

P = \text{expected/average packet size}
R = \text{transmission rate (M & B call it C)}
W = \text{expected \# of slots between transmissions}
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Probability Principles

- Principle 1: The probability that something won’t happen is 1 minus the probability that it will happen.
Principle 1: The probability that something won’t happen is 1 minus the probability that it will happen.

\[ P(\text{Sam I am}) = ? \]
\[ P(\text{I am not Sam}) = ? \]
Probability Principles

Principle 1: The probability that something won’t happen is 1 minus the probability that it will happen.

\[ P(\text{Emma I am}) = ? \]
\[ P(\text{I am not Emma}) = ? \]
\( A = \text{Probability that exactly 1 computer attempts a transmission in a given slot} \)

\[ W = \frac{1 - A}{A} = \frac{\text{Prob}(0 \text{ or } > 1 \text{ transmits})}{\text{Prob}(\text{exactly 1 transmits})} \]

\( W = \text{expected # of slots between transmissions} \)