CS 168 Introduction to the Internet: Architecture and Protocols
Fall 2022 Sylvia Ratnasamy Discussion 10: Advanced CC, DNS

1 AIMD Throughput

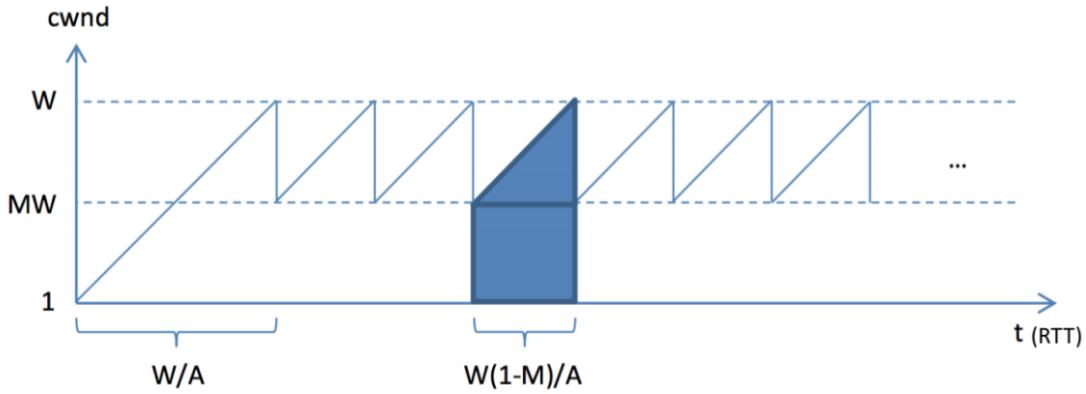

Figure 1: Graph of *Window size vs. time* referenced in AIMD Generalization and Derivation

Consider a generalized version of AIMD, where:

- For every window of data *ACK*ed, the window size increases by a constant A
- When the window size reaches W, a loss occurs, and the window size is multiplied by a constant $M < 1$

For simplicity, *assume that* $W(1-M)$ *is divisible by* A. Thus, the window sizes will cycle through the following: WM, $WM+A$, $WM+2A$, ... W. Let the RTT to denote the packet round trip time. A graph of window size versus time is referenced in Figure 1.

1. What is the average throughput? As we did in the lecture slides, express in your answers in the number of packets, so we do not need to consider MSS. **Solution:**

$$\begin{aligned}\text{Throughput} &= \frac{\text{Average number of packets in flight}}{\text{RTT}} \\ &= \frac{(MW+W)/2}{\text{RTT}} \\ &= \frac{W(M+1)}{2 \cdot \text{RTT}}\end{aligned}$$

2. Calculate the loss probability p, using W and M. **Solution:** We have one drop out of every $W(1-M)/A \cdot (MW+W)/2$ packets sent (the area of the shaded trapezoid in the plot). Thus the loss probability is as follows.

$$p = \frac{1}{\frac{W(1-M)}{A} \cdot \frac{MW+W}{2}} = \frac{2A}{W^2(1-M^2)}$$

3. Derive the formula for throughput in part 1 when $M = 0.5$ and $A = 1$ and try using only p and RTT.
   Solution:

$$\text{Throughput} = \frac{W(M+1)}{2 \cdot RTT} = \frac{3W}{4 \cdot RTT}$$
$$p = \frac{2A}{W^2(1-M^2)} = \frac{2}{0.75W^2} = \frac{8}{3W^2}$$

   We get $W = \sqrt{8/(3p)}$ from loss probability p, and plug this into throughput, and voila, we arrive at the following.

$$\begin{aligned}\text{Throughput} &= \frac{3W}{4 \cdot \text{RTT}} \\ &= \frac{3 \cdot \sqrt{8/(3p)}}{4 * \text{RTT}} \\ &= \sqrt{\frac{9 \cdot 8}{16 \cdot 3 \cdot p}} \frac{1}{\text{RTT}} \\ &= \frac{1}{\text{RTT}} \sqrt{\frac{3}{2p}}\end{aligned}$$

2 DNS True or False

1. Hosts usually perform the iterative DNS resolution process themselves.

   Solution: False; hosts use local DNS servers to perform DNS lookup.

2. Every zone always has at least 2 name servers.

   Solution: True.

3. When looking up a root server, BGP will use unicast to find the correct root server.

   Solution: False; BGP uses anycast to find the closest root server.

4. A client can establish a TCP connection with a root server.

   Solution: False; TCP requires keeping the state, but anycast does not guarantee all the packets of the same connection are sent to the same root server.

5. Most queries to DNS root servers are for nonexistent TLDs.

   Solution: True.

3 DNS Record Types

Write the corresponding DNS record type on the right column.

Information	Record Type
Name to IPV4 Address Mapping	A
Name to IPV6 Address Mapping	AAAA
Name Server	NS
Human Readable Information (Often Used for Site Verification)	TXT
General Name-to-Service Mapping	SRV
Mail Exchanger	MX
Canonical Name	CNAME