Prof. Danny Hughes
danny.hughes@cs.kuleuven.be

Computer Networks: Advanced Networks

Toon Nolten r0258654
toon.nolten@student.kuleuven.be

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1 Reference Models

1.1 Compare and contrast the OSI and TCP/IP reference models.

The OSI model was conceived as a model, there were no protocols that needed to fit the model. The TCP/IP model on the other hand was made to fit the existing TCP/IP protocols. As a consequence the TCP/IP model fits perfectly with the TCP/IP protocols but not at all with other protocols, so the model is of little use and the OSI model was made without experience in designing protocols, so some protocols can't fit the model and some model concepts are of little use (presentation and session layers).

1.2 Map the following protocols to the OSI stack

OSI Layer	Protocol
Application	BitTorent, HTTP, FTP
Presentation	
Session	SSL
Transport	TCP, UDP
Network	IPv4, IPv6
Data link	Ethernet, 802.11g
Physical	

1.3 Discuss, with reference to specific protocols the problem of ambiguity when mapping protocols to the OSI stack

SSL

SSL fits in the application layer as an application that encrypts your network traffic. But it also fits in the session layer because it provides a secure session. One could also argue for the presentation layer, you use encryption to represent your data.

RTP

RTP makes use of UDP for transmission and is implemented in user space, therefore it fits in the application layer. However, RTP offers a generic transport service (realtime transport), so it also fits in the transport layer.

DHCP

DHCP is an application that makes use of UDP broadcast, which means it fits in the application layer. But DHCP is used to acquire an IP address which is a network layer level address, so it could also be put in the network layer.

ARP

ARP resolves network layer addresses into link layer address. It fits in the network layer because it makes use of the link layer, it fits in the link layer because that's where it is used (to turn a network level address into a link level address).

DNS

DNS is placed in the application layer because it makes use of UDP. But it uses information about network layer addresses so it fits in the network layer.

TCP

TCP more or less fits in the network layer. However the network layer is best-effort and implemented throughout the network (in routers) so an extra layer is needed that ensures reliable transport and is completely controlled by your host.

2 Connection Establishment

2.1 Describe how the relationship between initial sequence numbers and time arises

To make sure that there is no window overlap after a crash we need a new sequence number to start our sliding window from, that is not in use anymore. To acquire such a number we need a realtime clock that keeps ticking during a crash, we can then take the lower-order bits of the clock as our new initial sequence number. This means the clock must advance slow enough not to wrap around during the crash.

2.2 Describe what the *forbidden region* of sequence numbers is and why this region exists

Any segment with a sequence number in the *forbidden region* should be discarded. This is because a segment with a *forbidden* sequence number could be a delayed segment.

2.3 Describe the limitations necessary to ensure that sequence numbers do not enter the *forbidden region*

There are two ways a host could enter the *forbidden region*, generating sequence numbers too fast or too slow with regard to the realtime clock. If sequence numbers are generated too fast the numbers can catch up with the *forbidden region* of segments that are still alive in the network. If sequence numbers are generated too slow, the *forbidden region* catches up with the sequence numbers you're using.

2.4 Demonstrate using a graph, the two ways in which a host could enter the *forbidden region*

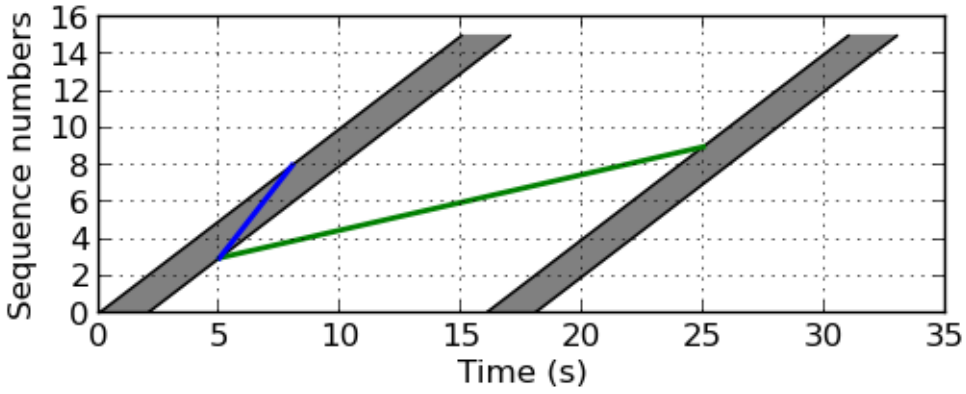

Figure 1: Entering the forbidden region

3 Congestion

3.1 Define the concepts of *Convergence* and *Oscillation*. What causes oscillation to occur?

Convergence is when the allocation of bandwidth stops changing. This allocation should ideally be fair and efficient. Oscillation is a repeated over- and underadjustment around the ideal point of convergence. Oscillation occurs when the adjustment of bandwidth allocation is too fast, which causes overshoot and succesive underadjustment, etc.

3.2 Describe the principles of the Additive Increase Multiplicative Decrease approach

Convergence can only be achieved if the rate of increase and decrease are not equal. Since congestion should be avoided at all cost, AIMD uses additive (slow) increase and multiplicative (fast) decrease. Because an increase in bandwidth is done additively it can take a long time after starting, to reach a reasonable bandwidth. To speed this up *slow start* was introduced, this increases bandwidth exponentially instead of additively, so it's much faster.

3.3 Demonstrate using a graph the convergence of AIMD towards the Optimal bandwidth allocation for two transport elements with equal performance transport layer connections.

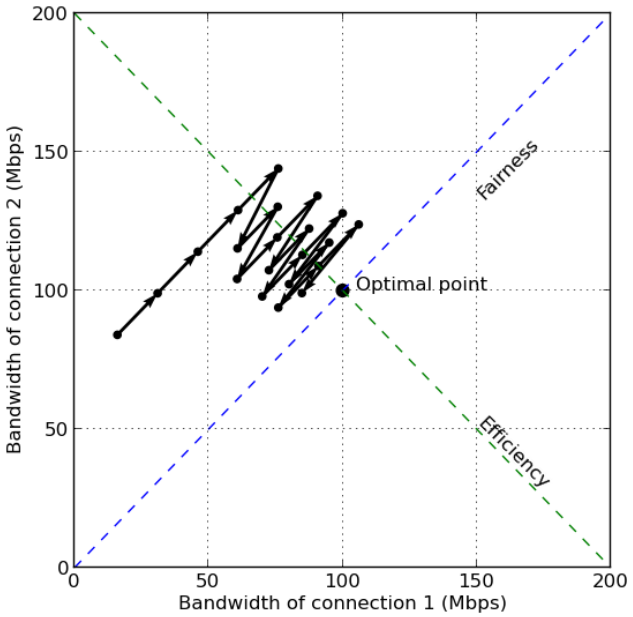

Figure 2: Additive Increase Multiplicative Decrease