CS4513 Project 3 Report

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Design, Result and Analysis:

1. Determine the data rate required for a movie query-response protocol and streaming of a typical text-based movie.

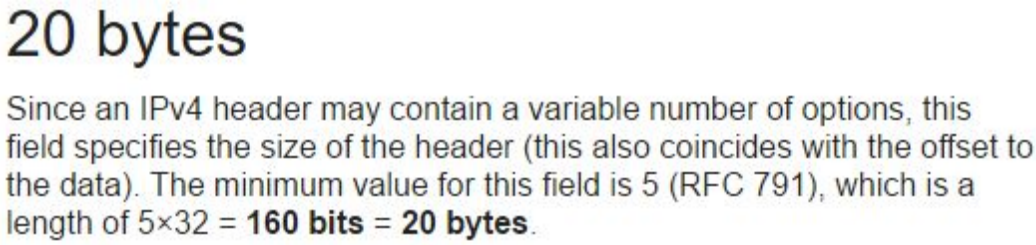
To estimate the data rate required, streaming the “Matrix” movie clip provided from CCCWORK4.WPI.EDU to CCCWORK2.WPI.EDU five times was conducted.
The timing result was shown in the following table:

Run number	Time (s)
1	31.16
2	31.14
3	31.01
4	31.00
5	31.06
Mean	31.074
Standard Deviation	0.073
Frame rate used	10 frames/s
Frame count	296
Total size	3228310 bytes

From the table above, we can tell that the sleep time between frames is 1/10 = 0.1s. And the size of one frame is 3228310/296 = 10906.5 bytes.
Since the frame is send through TCP, the actual size sending should include a TCP header, an IP header and an Ethernet header.
For TCP header, according to the figure below from Wikipedia, the size is assumed to be 30 bytes on average.

specifies the size of the TCP header in 32-bit words. The minimum size header is **5 words** and the maximum is **15 words** thus giving the minimum size of **20 bytes** and maximum of **60 bytes**, allowing for up to **40 bytes** of options in the header.

For IP header, since we are using IPv4, according to the figure below from Wikipedia, the size is 20 bytes.



For Ethernet MTU, according to the figure below from Wikipedia, the max size of ethernet packet is 1500 bytes plue 26 bytes of Ethernet header.

For query-response protocal, assume the “matrix” movie is used and there are two nutella peer running currently on “CCCWORK4.WPI.EDU” and “CCCWORK2.WPI.EDU”. The client of one peer first multicast movie name, then, the other peer response movie name plus host name plus port number, then, the first peer sends back “transfer” to start transfer. In this protocal, 3 packets are sent, and the size of a packet can be calculated by (size of string + TCP header + IP header + Ethernet header). According to this formula, the first packet would be 7 + 30 + 20 + 26 = 83 bytes. The second packet would be 7 + 16 + 4 + 2 + 30 + 20 + 26 = 105 bytes. The third packet would be 8 + 30 + 20 + 26 = 84 bytes. The total bytes sent would be 272 bytes. Assume this protocal needs to be finished in 0.1 second, the data rate required would be 272/0.1 = 2720 (bytes/sec).

For streaming a typical text-based movie like “matrix”, the max data size of a packet is 1500 - 20 - 30 = 1450 (bytes).
Thus, sending a frame needs 10906.5 / 1450 = 8 (packets). As a result, the total bytes of a frame including header should be 8 * 1526 = 12208 (bytes).
From the calculation above, we can tell that the data rate required for streaming a text-based movie with around 3.2 mb, 300 frames and 10 frames/sec should be 12208/0.1 = 122080 (bytes/sec) which is around 122 kb/s.

2. Assuming users continually watch movies, compute how many users Nutella could support on a typical LAN.

Assume the movie is the “Matrix” clip. The length of the movie is 3228310 bytes, the frame rate is 10 frames/s and there are 296 frames which means the frame size is 10906.5 bytes.

From the calculation above, we know that the minimum transfer rate needed for streaming “Matrix” is about 122 kb/s.

Fast Ethernet (100BASE-TX)	**100 Mbit/s**	12.5 MB/s	1995

From the figure above taken from Wikipedia, the typical LAN speed is about 1.25 mb/s.
As a result, Nutella could support 12.5 * 1024 / 122 = 110 users.

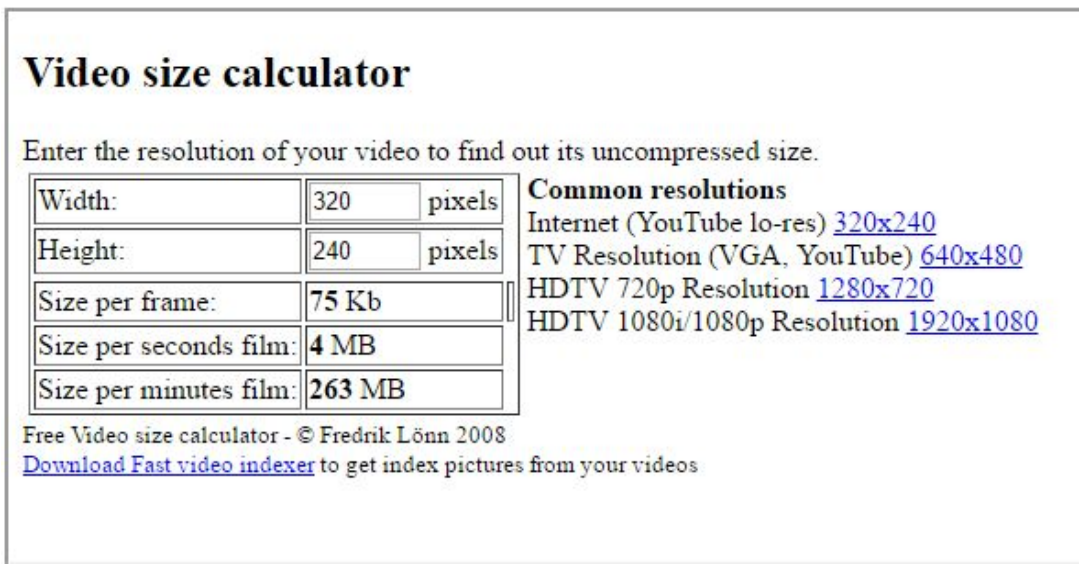
3. Assuming Nutella did multicast streaming in addition to multicast queries, compute how many users Nutella could support on a typical LAN.

If Nutella uses multicast streaming, for streaming movie, it can support as many users as connected. For receiving multicast queries, according to the calculation result and the typical LAN given above, it can support upto 12.5 * 1024 / 2.72 = 4705 users.

4. Repeat the same analysis for actual movies on a typical U.S.residential broadband netowrk.

- **50p/60p** is a progressive format and is used in high-end HDTV systems. While it is not technically part of the ATSC or DVB broadcast standards yet, reports suggest that higher progressive frame rates will be a feature of the next-generation high-definition television broadcast standards.[17] In Europe, the EBU considers 1080p50 the next step future proof system for TV broadcasts and is encouraging broadcasters to upgrade their equipment for the future.[18] Many modern cameras can shoot video at 50p and 60p in various resolutions. YouTube allowed users to upload videos at 60fps in June 2014. YouTube also allowed full HFR videos previously uploaded before 2014.

Figure for frame rate



Video size calculator

Enter the resolution of your video to find out its uncompressed size.

Width:	320	pixels
Height:	240	pixels
Size per frame:	**75** Kb	
Size per seconds film:	**4** MB	
Size per minutes film:	**263** MB	

Common resolutions
Internet (YouTube lo-res) 320x240
TV Resolution (VGA, YouTube) 640x480
HDTV 720p Resolution 1280x720
HDTV 1080i/1080p Resolution 1920x1080

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Figure for sigle frame size

Assume the length of the movie is 30 minutes, the frame rate is 60 frames/sec according to the figure above from Wikipedia, the size of one frame is 75 kb according to the figure above and the total length of exchanging protocol is 3 kb.
The size of this movie would be 75 * 60 * 60 * 30 = 8100000 = 7.7 Gb.

The speed for typical U.S. network given by Wikipedia is shown below:

Country/Territory	Avg. connection speed (Mb/s)
United States	12.6

a. Assuming users continually watch movies, compute how many users a typical U.S. residential broadband network can support.

A single frame is 768000 bytes. According to the Ethernet MTU data above, it needs 768000/1450 = 53 (packets), thus 53 * 1526 = 80878 total bytes sent.
The minimum speed needed to streaming this movie is 80878 / (1/60) = 4852680 (bytes/sec) = 4.63 mb/s.
As a result, the average U.S. network can support upto 12.6/4.63 = 3 users watching together.

b. Assuming multicast streaming and multicast queries are used, compute how many users could be supported.

For just streaming movies, it can support as many users as connected, for receiving queries, it can support 12.6 * 1024 / 3 = 4300 users.

The table below shows the comparison between a text base movie on a typical LAN and an actual movie on a typical U.S. residential broadband network.

	User continuous watch movies	Use multicast streaming and multicast queries
Text-based movie	110 users	4705 users
Actual movie	3 users	4300 users

From the table above, we can tell that under almost the same network condition, transfering text-based movie can support much more movie under unicast situation. When using multicast streaming and multicast queries, transfering both kinds of movies supports almost the same users. Also, using multicast streaming and multicast queries can support much more user than using unicast streaming.