title: Assignment 1 subtitle: Computer performance, reliability, and scalability calculation author: Reenie Christudass

Assignment 1.2

a. Data Sizes

Data Item	Size per Item
1. 128 character message.	128 Bytes
2. 1024x768 PNG image	0.75 MB
3. 1024x768 RAW image	2.25 MB
4. HD (1080p) HEVC Video (15 minutes)	2,649.50 MB
5. HD (1080p) Uncompressed Video (15 minutes)	160,546.88 MB
6. 4K UHD HEVC Video (15 minutes)	12,549.84 MB
7. 4k UHD Uncompressed Video (15 minutes)	605,621.3 MB
8. Human Genome (Uncompressed)	0.75 GB

1. 128 Characters = 128 bytes
2. I will use 24 bit (ie 3 bytes) for PNG image (compressed)

```
 1. Total pixel count. 1024*768 =  786,432 pixels
 2. Multiply the total pixel count by 3 to get the image size in b
ytes. 786,432 pixels * 3 = 2,359,296 bytes
 3. Compression level for PNG images is between 0 to 9, with 0 bei
ng no compression and 9 being maximum compression.
 Assuming a typical PNG compression ratio of 5:1
     Compressed size = 2,359,296 bytes / 5 = 471,859.2 bytes
 3. Divide the number of bytes by 1024 to get the image size in ki
lobytes. 471,859.2 bytes/1024 = 460.8 KB
 4. Divide the number of kilobytes by 1024 to get the image size i
n megabytes.460.8 KB /1024 = 0.45 MB
```

3. I will use 24 bit (ie 3 bytes) for RAW image (Uncompressed)

```
1. Total pixel count. 1024*768 =  786,432 pixels
2. Multiply the total pixel count by 3 to get the image size in by
tes. 786,432 pixels * 3 = 2,359,296 bytes
3. Divide the number of bytes by 1024 to get the image size in kil
obytes. 2,359,296 bytes/1024 = 2304 KB
4. Divide the number of kilobytes by 1024 to get the image size in
megabytes.2304 KB /1024 = 2.25 MB
```

4. Total number of frames in the video: 30 frames per second x 900 seconds = 27,000 frames

The total number of bits used to encode one frame: 3 bytes per pixel x 1920 pixels x 1080 pixels = 6,220,800 bits per frame

Entire video: 24,883,200 bits per frame x 27,000 frames = 168,266,400,000 bits

Convert the total number of bits to gigabits: 168,266,400,000 bits / 1,000,000,000 = 168.2664 gigabits

Calculate the bitrate of the video: 168.2664 gigabits / 900 seconds = 186.9627 Mbps

Finally, calculate the file size of the video: 186.9627 Mbps x 900 seconds = 21,196.01 megabits 21,196.01 megabits / 8 = 2,649.50 megabytes (MB)

5. Calculate the file size of an uncompressed video 1080p (1920 x 1080 pixels)

Resolution: 1920 pixels × 1080 pixels Frame rate: 30 frames per second Duration: 900 seconds Pixel format: 3 bytes per pixel (24 bits per pixel)

```
1920 * 1080 * 30 * 900 * 3 = 168,399,360,000 bytes

168,399,360,000 bytes /1024/1024 = 160,598.1 MB
```

6. Total number of frames in the video: 30 frames per second x 900 seconds = 27,000 frames

The total number of bits used to encode one frame: 3 bytes per pixel x 3840 pixels x 2160 pixels = 24,883,200 bits per frame

Entire video: 24,883,200 bits per frame x 27,000 frames = 671,846,400,000 bits

Convert the total number of bits to gigabits: 671,846,400,000 bits / 1,000,000,000 = 671.8464 gigabits

Calculate the bitrate of the video: 671.8464 gigabits / 900 seconds = 746.496 Mbps

Finally, calculate the file size of the video: 746.496 Mbps x 900 seconds = 100,398.72 megabits 100,398.72 megabits / 8 = 12,549.84 megabytes (MB)

7. Calculate the file size of an uncompressed video 4K (3840 x 2160 pixels)

Resolution: 1920 pixels × 1080 pixels Frame rate: 30 frames per second Duration: 900 seconds Pixel format: 3 bytes per pixel (24 bits per pixel)

```
1920 * 1080 * 30 * 900 * 3 = 635,040,000,000 bytes

635,040,000,000 bytes /1024/1024 = 605,621.3 MB
```

8. The human genome is a sequence of approximately 3 billion base pairs (3 billion * 2)

   6,000,000,000 bits / 8 = 750,000,000 bytes 750,000,000 bytes /1024/1024/1024 = 0.75 GB

b. Scaling

	Size	# HD
1. Daily Twitter Tweets (Uncompressed)	64 GB	1

	Size	# HD
2. Daily Twitter Tweets (Snappy Compressed)	40 GB	1
3. Daily Instagram Photos	45000 GB	5
4. Daily YouTube Videos	2,519,424 GB	251
5. Yearly Twitter Tweets (Uncompressed)	280,320 GB	28
6. Yearly Twitter Tweets (Snappy Compressed)	30,720 GB	31
7. Yearly Instagram Photos	34,560,000 GB	3456
8. Yearly YouTube Videos	1,934,917,632 GB	193492

One hard drive in 10TB

1. Daily Twitter Tweets (Uncompressed)

500,000,000 Tweets a days * 128 character = 64,000,000,000 Bytes

2. Daily Twitter Tweets (Snappy Compressed)

Reference : https://github.com/google/snappy (https://github.com/google/snappy)

Snappy is a compression/decompressio

n library. It does not aim for maximum compression, or compatibility with any other compression library; instead, it aims for very high speeds and reasonable compression. For instance, compared to the fastest mode of zlib, Snappy is an order of magnitude faster for most inputs, but the resulting compressed files are anywhere from 20% to 100% bigger.

Snappy compresses 1.5-1.7x for plain text, 2-4x for HTML, and 1.0x for JPEGs, PNGs

For this example i will use 1.6 compression

64,000,000,000 Bytes / 1.6 = 40,000,000,000 bytes

3. Daily Instagram Photos

Instagram statistics estimates over 100 million videos and photos are uploaded to Instagram every day. Assume that 75% of those items are 1024x768 PNG photos.

For the assignment i will consider 100 million photos uploaded for instagram on a day

One photo from the above calculation:

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0.45 MB
```

100 million photo:

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0.45 * 100,000,000 = 45,000,000 MB = 45000 GB
```

4. Daily YouTube Videos
   A. Total number of frame a minute of video = 30 frames per second x 60 seconds per minute x 1,800,000 = 3,240,000,000 frames frames

B. The total number of bits used to encode one frame: 3 bytes per pixel x 1920 pixels x 1080 pixels = 6,220,800 bits per frame
C. total number of bits in one minute of video:3,240,000,000 frames x 6,220,800 bits per frame = 2.0155392e+16 bits
D. Determine the total number of gigabytes in one minute of video: 2.0155392e+16 bits / 8 / 1,000,000,000 = 2,519,424 GB

c. Reliability

	# HD	# Failures
Twitter Tweets (Uncompressed)	1	0
Twitter Tweets (Snappy Compressed)	1	0
Instagram Photos	5	1
YouTube Videos	251	1

https://www.backblaze.com/b2/hard-drive-test-data.html (https://www.backblaze.com/b2/hard-drive-test-data.html)

d. Latency

	One Way Latency
Los Angeles to Amsterdam	149 ms
Low Earth Orbit Satellite	638 ms
Geostationary Satellite	240-279 ms
Earth to the Moon	1300 s
Earth to Mars	3 minutes

1. https://www.hugeserver.com/about/network/ (https://www.hugeserver.com/about/network/)
2. https://news.viasat.com/blog/satellite-internet/satellite-internet-latency-whats-the-big-deal (https://news.viasat.com/blog/satellite-internet/satellite-internet-latency-whats-the-big-deal)
3. https://www.satsig.net/latency.htm (https://www.satsig.net/latency.htm)
4. https://www.spaceacademy.net.au/spacelink/commdly.htm (https://www.spaceacademy.net.au/spacelink/commdly.htm)
5. https://www.forbes.com/sites/quora/2016/08/31/when-we-eventually-get-to-mars-this-is-how-the-internet-will-work-there/?sh=23e129b7dae7 (https://www.forbes.com/sites/quora/2016/08/31/when-we-eventually-get-to-mars-this-is-how-the-internet-will-work-there/?sh=23e129b7dae7)

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