Media Signal Processing

4c8 Media Signal Processing

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Introduction

4c8 is an introduction to the digital **Signal Processing** algorithms that are at the core of **Image and Video Compression**.

2D Signal Processing concepts such as 2D Convolution, 2D Z-Transforms and 2D Discrete Fourier Transforms.

Compression Algorithms for Images and Videos such as JPEG and MPEG2.

Course Structure

Monday 1-2pm [M20]

Tuesday 9:30-11am [EELabs]

Thursday 11-12am [M21]

Friday 2-3pm [M21]

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lectures/tutorials: on Monday, Thursday, Friday

labs: on Wednesdays 9-11pm, **25% of the final mark**

exam: 2 hours, same format as last year

Course Prerequisites

Signal Processing prerequisites include:

- mainly 3c1 but 4c5 helps too
- Z-Transform
- Convolution
- Fourier Transform

Information Theory prerequisites include:

- Entropy, Entropy Rate, Shannon's Coding Theorem etc.
- Huffman Coding

(these will be covered again for the BIO stream.)

Remark

This course is built upon course material from Assistant **Prof. David Corrigan** and **Prof. Anil Kokaram**, who were teaching 4c8 in previous years.

Introduction: What does YouTube do to your video?

https://youtu.be/IlFmBbeKRXQ

Anatomy of a Picture

resolution: 600 x 400 pixels

sRGB colour space

8bit per colour channel (0-255)

it could be floating point (0-1)

The Rise of Digital Media

1920's	First Digital Images
1960s	Digital Image Processing Research takes off
1970s	Medical Imaging emerges (eg. CAT)
1973	DIP used for first time in the cinema (Westworld). Introduction of Introduction of Digital Video in Television Production
1980s	Introduction of Digital Video cameras and tape (DigiBeta and DV standard)
2000s	Digital Television and DVD emerges
	Video on mobile phones / video over internet/ HDTV / 3DTV
Late 90s	Online streaming of high quality Video (incl. 4k) (Netflix, Youtube etc.)
Now	

Why Compression?

Why Compression?

In the days of standard definition TV, the resolution was 720×576 pixels, with 3 colours per pixel (3 × 8 = 24 bits per pixel) at 25 fps.

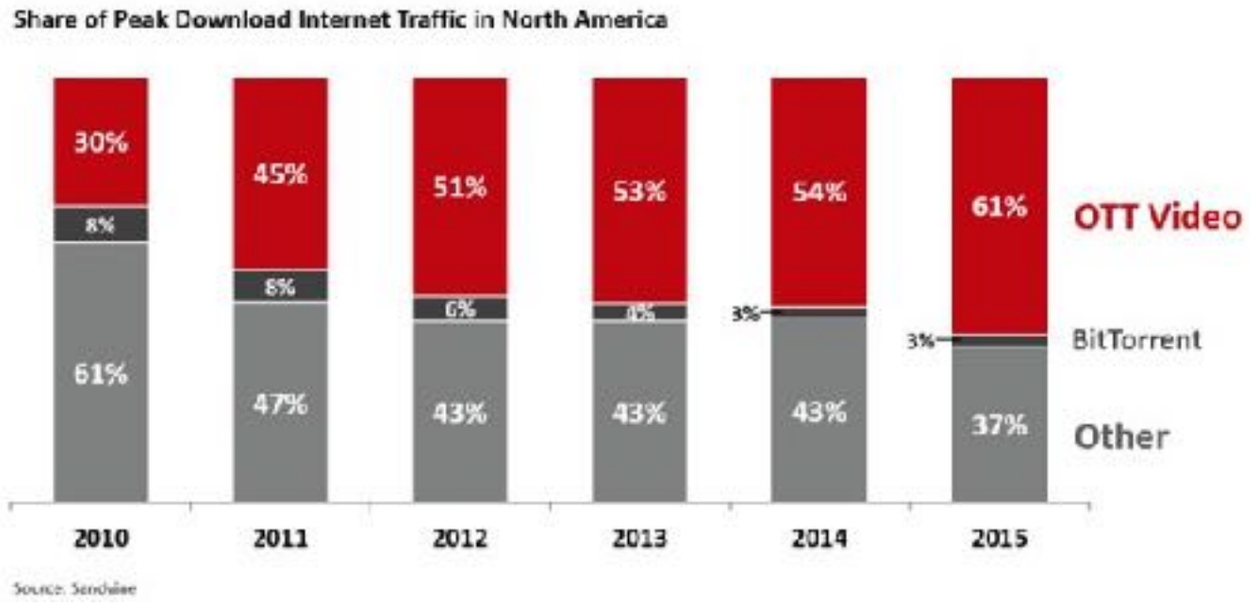
Let's look at the **Bandwidth** of the uncompress stream:

SD = 720 x 576 x 24 bpp x 25 fps ≈ 250 mbps

HD : 1920 x 1080 x 24 bpp x 60 fps ≈ 3 gbps

3D Cinema : 4096 x 2160 x 36 bpp x 48 fps x 2 ≈ 30 gbps

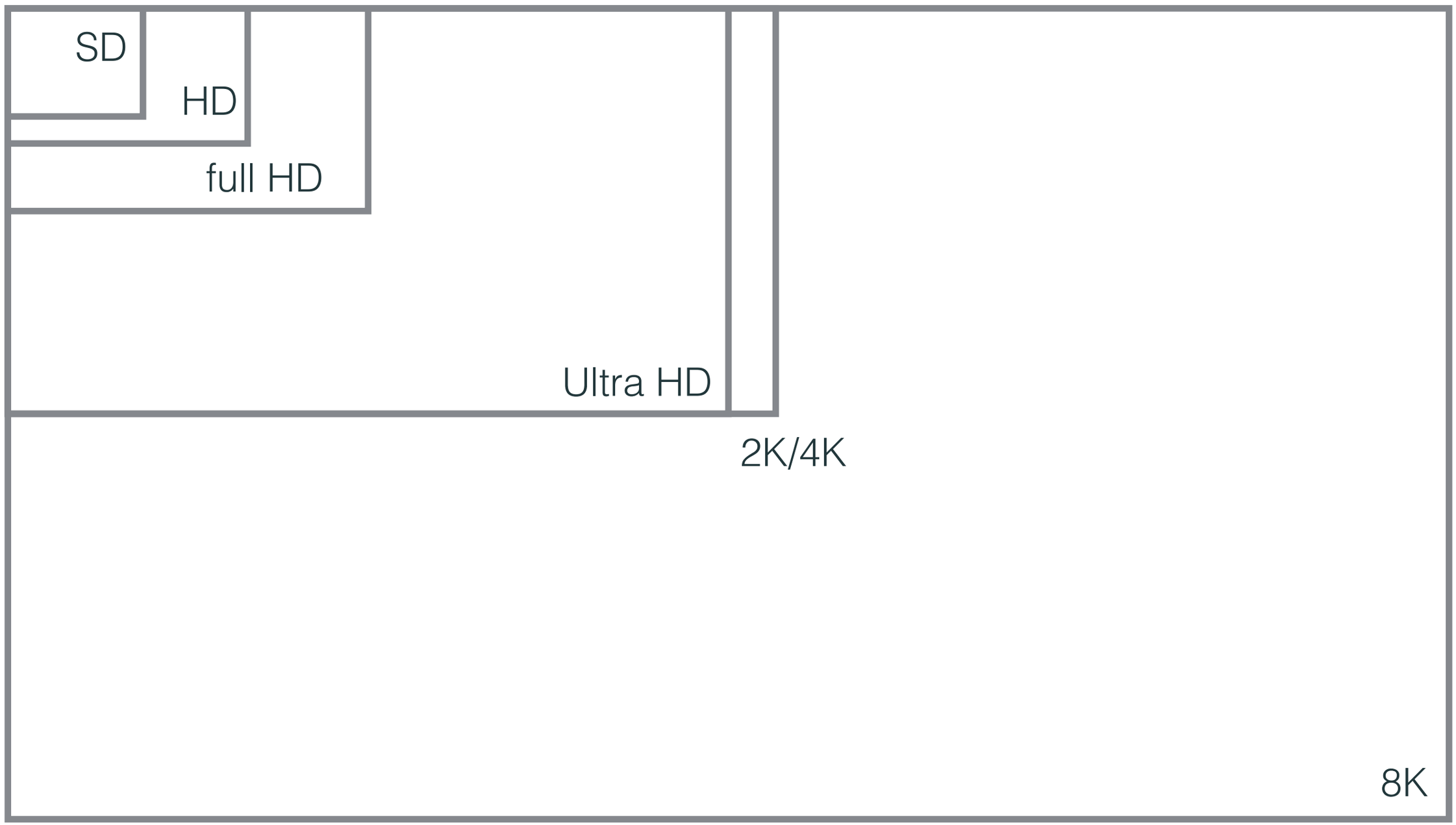
Why Compression?



Video streaming is 60% of the Internet traffic.

1% compression improvement means 100’s of millions of $ in bandwidth and storage savings.

Future Demand: 8K is already here



YouTube already streams in 8K

Future Demand: HDR TV

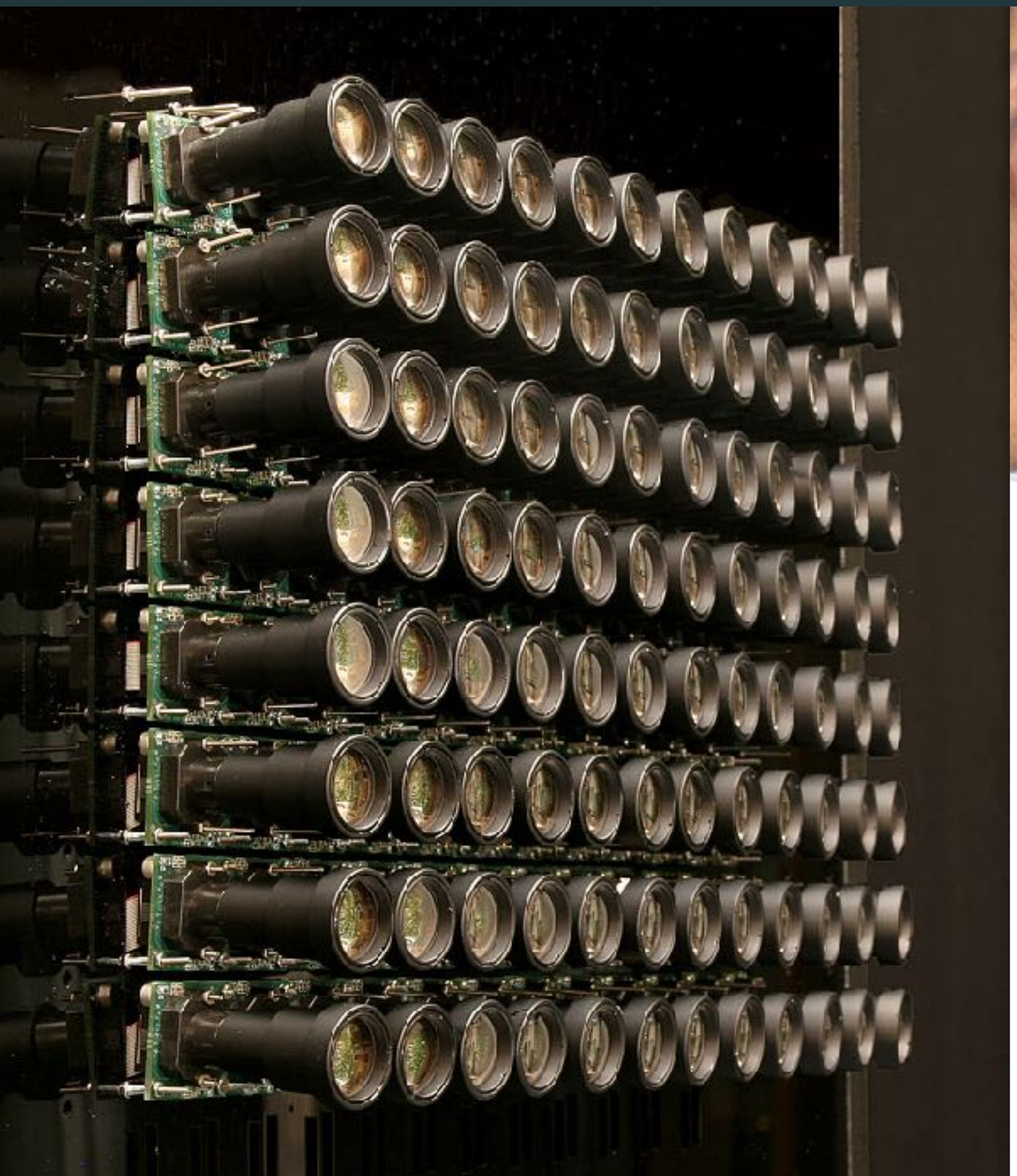
from 8 bits per pixel … to 12,14,16 bpp

Future Demand: VR

We want 16K at 120 fps in stereo 3D.

```
raw bandwidth = 1 tbps
```

Future Demand: LightField Imaging



We want to see the light from all angles.

```
raw bandwidth = 14 tbps
```

Do Uncompressed Images Exist?

Digital Cameras have builtin hardware compression on the chip, even for high end cameras like Arri and RED.

Cinema PostProduction Companies store images using lossless image compression (EXR file format).

When working with images, the main concerns are always memory cache and data bandwidth (eg. between GPU and CPU). As a result, we almost never look at an entire picture, we only look at small blocks of the picture and compress the pictures for fast transfer.

Videos are just big, you need to compress them.

Books & Blogs

Digital Image Processing. Gonzalez and Woods. Prentice Hall (a good general purpose image processing text book)

JPEG: Still Image Processing Standard. Pennebaker and Mitchell. Van Nostrand Reinhold. (a reference for JPEG)

Digital Video: An Introduction to MPEG2. Haskell, Puri and Netravali. Chapman and Hall (a reference for MPEG2)

Notes from old course

Engineering Blogs from YouTube and Netflix:

https://youtube-eng.googleblog.com/

http://techblog.netflix.com/