# Analysis and Shaping of Video Traffic

Prepared for UCC Networking  Course, June - August 2012.

## Purpose of this lab:

This labs is about analyzing and presenting data on video traffic.

## Software Tools:

- You need a software package that can read large amounts  of data, and prepare graphs, e.g., Excel.

## What to turn in:

- Turn in a report with your answers to the questions in this lab, including the plots, hard copies of all your Java code, and the anonymous feedback form.

## What to turn in:

- A typewritten write-up of your answers to the questions, including the plot. Please submit via the Dropbox.

- When you present a plot, provide a description which includes units of the axes, explanation of the legend, description of each graph, etc.

- The symbol             indicates questions for the lab report.

- The lab exercises and the lab reported are  to be completed individually.

- The estimated time to complete the lab is 3 hours.

In this part of the lab, you will explore the properties of a traffic flow that consists of compressed digital video traffic.

Digital video consists of a sequence of video frames that are displayed at a rate of typically 30 frames per seconds. Assuming a frame size of 720 x 480 pixels (a standard format used for digital video) and a depth of 24 bits per pixel, this results in a data rate 240 Mbps per video stream. Using modern compression methods, such as MPEG and H.264, the data rate can be drastically reduced to a few Mbps.

An MPEG encoder (and most other compression algorithms) generates three types of frames: Intra-coded (I), Inter-coded or predictive (P), and bi-directional (B). I frames are coded as still images not unlike JPEG; P frames encode the differences from the most recent I or P frame; and B are interpolations of the next and previous I or P frames. An MPEG encoder generates these frames in a repeating pattern, called the Group-of-Picture (GOP) pattern. With 30 frames per second, the elapsed time between two frames is approximately 33 ms. A typical GOP pattern of IBBPBBPBB, where the dependencies between frames is indicated by arrows, is shown in the following figure:
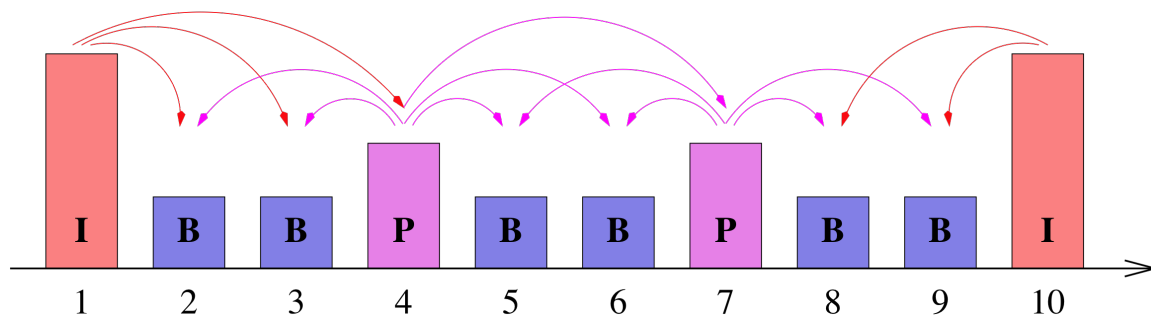


As indicated in the figure, frame types have different sizes, with I frames being the largest and B frames the smallest. Note that a B frame is constructed from two reference frames of type I or P (e.g., Frame 3 above depends on Frame 1 and Frame 4). Thus, to encode or decode a B frame the transmitter or receiver must have available the next I or P frame. To account for this need, frames are transmitted in a different sequence than they are displayed. In the above example, the display and transmission sequence is as follows:

```
Display sequence:   1      2    3    4    5    6    7    8    9    10
Transmit sequence:  1      4    2    3    7    5    6    10   8    9
```

## 1. Download a VBR video trace

Your first task is to download a file that contains a trace of a VBR video source. The file contains the frame sizes obtained from a compression of a picture movie. The size of the file is 4.2 MB.

**Content: Harry Potter (~ 30 min)**

| | |
|---|---|
| Frame size and rate: | High Definition 1920x1088 @24 fps (frames per second) |
| Compression Algorithm: | H.264/SVC (Full) |
| GoP Pattern: | I B B B P B B B P B B B P B B B |
| Number of Frames: | ~85000 |

Download the verbose encoder version of the trace file from the following URL:
http://trace.eas.asu.edu/vtraces2_scripts/trace_options.php?id=2&gopid=G16B3&fps=24&qI=22&qP=22&qB=24&path=/trace/traceWeb/htdocs/videotraces2/svc_single/1080/harrypotter/harrypotter1080_G16B3/222224

- Explore the content of the file. The file contains one line for each frame and has multiple columns. The first four columns are relevant for us:
  - Column 1: Sequence number of the frame (in transmit sequence)
  - Column 2: Display time of the frame
  - Column 3: Frame type
  - Column 4: Frame size in bytes
  - Columns 5 – 7: not used

## 2. Determine statistical properties of the video trace

- Compute the following properties of the video trace.

  - Number of frames and total number of bytes;
  - Size of the smallest frame, size of the largest frame, and mean frame size;
  - Mean bit rate (Computed as the mean frame size divided by the frame duration);
  - Peak bit rate (Computed as the max. frame size divided by the frame duration);
  - Ratio of the peak rate and the average rate. This peak-to-average rate ratio is often used as an indicator how bursty a traffic flow is. A flow with a peak-to-average ratio of 10 or higher is highly variable.

- Generate a plot that shows the size of a frame as a function of time.

## 3. Arrival function and empirical envelope

- Plot the arrival function $A(t)$ for the VBR video trace, where $A(t)$ are the total number of bytes in the time interval $[0,t)$.