

# FFMPEG Basics

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- And many other new filters, and accelerated code path improvements.

## How to Install FFmpeg 4.0 in Ubuntu:

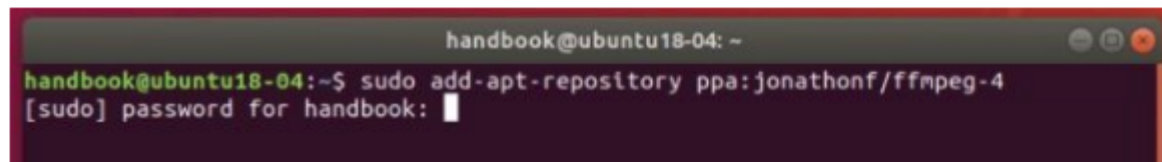
FFmpeg 4.0.2 is available in Ubuntu Software via [SNAP](#) package (Runs in sandbox).

To upgrade from the Ubuntu build FFmpeg 3.x, the [unofficial PPA](#) contains the latest packages for Ubuntu 18.04, Ubuntu 16.04, and Ubuntu 14.04.

**1.** Open terminal either via **Ctrl+Alt+T** keyboard shortcut, or by searching for 'terminal' from software launcher. When it opens, run command to add the PPA:

```
sudo add-apt-repository ppa:jonathonf/ffmpeg-4
```

*Type user password (no asterisks feedback) when it prompts and hit Enter.*

A terminal window with a dark background and light text. The title bar shows 'handbook@ubuntu18-04: ~'. The terminal content shows the command 'sudo add-apt-repository ppa:jonathonf/ffmpeg-4' being entered, followed by the prompt '[sudo] password for handbook:' and a cursor. The window has standard Ubuntu window controls (minimize, maximize, close) in the top right corner.

```
handbook@ubuntu18-04: ~  
handbook@ubuntu18-04:~$ sudo add-apt-repository ppa:jonathonf/ffmpeg-4  
[sudo] password for handbook: █
```

**2.** You can then upgrade FFmpeg libraries via Software Updater:

```
wrg@wrg-900X5N:~/study/live_stream$ ffmpeg
ffmpeg version 4.1.1-0york1~16.04 Copyright (c) 2000-2019 the FFmpeg developers
  built with gcc 5.4.0 (Ubuntu 5.4.0-6ubuntu1~16.04.11) 20160609
  configuration: --prefix=/usr --extra-version='0york1~16.04' --toolchain=hardened --libdir=
/usr/lib/x86_64-linux-gnu --incdir=/usr/include/x86_64-linux-gnu --arch=amd64 --enable-gpl -
-disable-stripping --enable-avresample --disable-filter=resample --enable-avisynth --enable-
gnutls --enable-ladspa --enable-libaom --enable-libass --enable-libbluray --enable-libbs2b -
-enable-libcaca --enable-libcdio --enable-libcodec2 --enable-libflite --enable-libfontconfig
--enable-libfreetype --enable-libfribidi --enable-libgme --enable-libgsm --enable-libjack -
-enable-libmp3lame --enable-libmysofa --enable-libopenjpeg --enable-libopenmpt --enable-libo
pus --enable-libpulse --enable-librsvg --enable-librubberband --enable-libshine --enable-lib
snappy --enable-libsoxr --enable-libspeex --enable-libssh --enable-libtheora --enable-libtwo
lame --enable-libvidstab --enable-libvorbis --enable-libvpx --enable-libwavpack --enable-lib
webp --enable-libx265 --enable-libxml2 --enable-libxvid --enable-libzmq --enable-libzvbi --e
nable-lv2 --enable-omx --enable-opengl --enable-sdl2 --enable-nonfree --enab
le-libfdk-aac --enable-libdc1394 --enable-libdrm --enable-libiec61883 --enable-chromaprint -
-enable-frei0r --enable-libx264 --enable-shared
  libavutil      56. 22.100 / 56. 22.100
  libavcodec     58. 35.100 / 58. 35.100
  libavformat    58. 20.100 / 58. 20.100
  libavdevice    58.  5.100 / 58.  5.100
  libavfilter    7. 40.101 / 7. 40.101
  libavresample  4.  0.  0 / 4.  0.  0
  libswscale     5.  3.100 / 5.  3.100
  libswresample  3.  3.100 / 3.  3.100
  libpostproc   55.  3.100 / 55.  3.100
Hyper fast Audio and Video encoder
usage: ffmpeg [options] [[infile options] -i infile]... {[outfile options] outfile}...

Use -h to get full help or, even better, run 'man ffmpeg'
wrg@wrg-900X5N:~/study/live_stream$
```

```
wrg@wrg-900X5N:~/study/live_stream$ youtube-dl https://www.youtube.com/watch?v=qStRYrJUMrI&t=1s
[1] 7784
wrg@wrg-900X5N:~/study/live_stream$ [youtube] qStRYrJUMrI: Downloading webpage
[youtube] qStRYrJUMrI: Downloading video info webpage
[youtube] qStRYrJUMrI: Extracting video information
WARNING: unable to extract uploader nickname
[download] Destination: 스타크래프트 II - 군단의 심장 - 오프닝 시네마틱 영상-qStRYrJUMrI.f137.mp4
[download] 100% of 33.78MiB in 01:09
[download] Destination: 스타크래프트 II - 군단의 심장 - 오프닝 시네마틱 영상-qStRYrJUMrI.f140.m4a
[download] 100% of 2.61MiB in 01:08
[ffmpeg] Merging formats into "스타크래프트 II - 군단의 심장 - 오프닝 시네마틱 영상-qStRYrJUMrI.mp4"
Deleting original file 스타크래프트 II - 군단의 심장 - 오프닝 시네마틱 영상-qStRYrJUMrI.f137.mp4 (pass -k to keep)
Deleting original file 스타크래프트 II - 군단의 심장 - 오프닝 시네마틱 영상-qStRYrJUMrI.f140.m4a (pass -k to keep)

[1]+  Done                  youtube-dl https://www.youtube.com/watch?v=qStRYrJUMrI
wrg@wrg-900X5N:~/study/live_stream$
```

```
wrg@wrg-900X5N:~/study/live_stream$ youtube-dl https://www.youtube.com/watch?v=qStRYrJUMrI&t=1s
[1] 7784
wrg@wrg-900X5N:~/study/live_stream$ [youtube] qStRYrJUMrI: Downloading webpage
[youtube] qStRYrJUMrI: Downloading video info webpage
[youtube] qStRYrJUMrI: Extracting video information
WARNING: unable to extract uploader nickname
[download] Destination: 스타크래프트 II - 군단의 심장 - 오프닝 시네마틱 영상-qStRYrJUMrI.f137.mp4
[download] 100% of 33.78MiB in 01:09
[download] Destination: 스타크래프트 II - 군단의 심장 - 오프닝 시네마틱 영상-qStRYrJUMrI.f140.m4a
[download] 100% of 2.61MiB in 01:08
[ffmpeg] Merging formats into "스타크래프트 II - 군단의 심장 - 오프닝 시네마틱 영상-qStRYrJUMrI.mp4"
Deleting original file 스타크래프트 II - 군단의 심장 - 오프닝 시네마틱 영상-qStRYrJUMrI.f137.mp4 (pass -k to keep)
Deleting original file 스타크래프트 II - 군단의 심장 - 오프닝 시네마틱 영상-qStRYrJUMrI.f140.m4a (pass -k to keep)

[1]+  Done                  youtube-dl https://www.youtube.com/watch?v=qStRYrJUMrI
wrg@wrg-900X5N:~/study/live_stream$ ls
스타크래프트 II - 군단의 심장 - 오프닝 시네마틱 영상-qStRYrJUMrI.mp4
wrg@wrg-900X5N:~/study/live_stream$ mv 스타크래프트\ II\ -\ 군단의\ 심장\ -\ 오프닝\ 시네마틱\ 영상-qStRYrJUMrI.mp4 star2_zerg.mp4
wrg@wrg-900X5N:~/study/live_stream$ ls
star2_zerg.mp4
wrg@wrg-900X5N:~/study/live_stream$
```

```
wrg@wrg-900X5N:~/study/live_stream$ youtube-dl https://www.youtube.com/watch?v=dvrQciFL0ig
[youtube] dvrQciFL0ig: Downloading webpage
[youtube] dvrQciFL0ig: Downloading video info webpage
[youtube] dvrQciFL0ig: Extracting video information
WARNING: unable to extract uploader nickname
WARNING: Requested formats are incompatible for merge and will be merged into mkv.
[download] Destination: Electromagnetic Plasma Rifle Test Fire-dvrQciFL0ig.f135.mp4
[download] 100% of 12.68MiB in 00:29
[download] Destination: Electromagnetic Plasma Rifle Test Fire-dvrQciFL0ig.f251.webm
[download] 100% of 1.54MiB in 00:26
[ffmpeg] Merging formats into "Electromagnetic Plasma Rifle Test Fire-dvrQciFL0ig.mkv"
Deleting original file Electromagnetic Plasma Rifle Test Fire-dvrQciFL0ig.f135.mp4 (pass -k to keep)
Deleting original file Electromagnetic Plasma Rifle Test Fire-dvrQciFL0ig.f251.webm (pass -k to keep)
wrg@wrg-900X5N:~/study/live_stream$ ls
Electromagnetic Plasma Rifle Test Fire-dvrQciFL0ig.mkv  star2_zerg.mp4
wrg@wrg-900X5N:~/study/live_stream$ mv Electromagnetic\ Plasma\ Rifle\ Test\ Fire-dvrQciFL0ig.mkv r
ailgun.mkv
wrg@wrg-900X5N:~/study/live_stream$ ls
railgun.mkv  star2_zerg.mp4
wrg@wrg-900X5N:~/study/live_stream$ █
```



```
wrg@wrg-900X5N:~/study/live_stream$ ls
railgun.mkv  star2_zerg.mp4
wrg@wrg-900X5N:~/study/live_stream$ ffplay railgun.mkv
ffplay version 4.1.1-0york1~16.04 Copyright (c) 2003-2019 the FFmpeg developers
  built with gcc 5.4.0 (Ubuntu 5.4.0-6ubuntu1~16.04.11) 20160609
  configuration: --prefix=/usr --extra-version='0york1~16.04' --toolchain=hardened --libdir=/usr/li
b/x86_64-linux-gnu --incdir=/usr/include/x86_64-linux-gnu --arch=amd64 --enable-gpl --disable-strip
```



```
HANDLER_NAME      : VideoHandler
DURATION           : 00:01:28.054000000
Stream #0:1(eng):  Audio: opus, 48000 Hz, stereo, fltp (default)
Metadata:
  DURATION          : 00:01:28.601000000
67.29 A-V: -0.013 fd=  0 aq=  18KB vq= 124KB sq=  0B f=0/0
```

```
wrg@wrg-900X5N:~/study/live_stream$ ls
railgun.mkv  star2_zerg.mp4
wrg@wrg-900X5N:~/study/live_stream$ ffplay railgun.mkv
ffplay version 4.1.1-0york1~16.04 Copyright (c) 2003-2019 the FFmpeg developers
  built with gcc 5.4.0 (Ubuntu 5.4.0-6ubuntu1~16.04.11) 20160609
  configuration: --prefix=/usr --extra-version='0york1~16.04' --toolchain=hardened --libdir=/usr/li
b/x86_64-linux-gnu --incdir=/usr/include/x86_64-linux-gnu --arch=amd64 --enable-gpl --disable-strip
ping --enable-avresample --disable-filter=resample --enable-avisynth --enable-gnutls --enable-ladsp
a --enable-libaom --enable-libass --enable-libbluray --enable-libbs2b --enable-libcaca --enable-lib
cdio --enable-libcodec2 --enable-libflite --enable-libfontconfig --enable-libfreetype --enable-libf
ribidi --enable-libgme --enable-libgsm --enable-libjack --enable-libmp3lame --enable-libmysofa --en
able-libopenjpeg --enable-libopenmpt --enable-libopus --enable-libpulse --enable-librsvg --enable-l
ibrubberband --enable-libshine --enable-lbsnappy --enable-libsoxr --enable-libspeex --enable-libss
h --enable-libtheora --enable-libtwolame --enable-libvidstab --enable-libvorbis --enable-libvpx --e
nable-libwavpack --enable-libwebp --enable-libx265 --enable-libxml2 --enable-libxvid --enable-libzm
q --enable-libzvb1 --enable-lv2 --enable-omx --enable-openal --enable-opengl --enable-sdl2 --enable
-nonfree --enable-libfdk-aac --enable-libdc1394 --enable-libdrm --enable-libiec61883 --enable-chrom
aprint --enable-frei0r --enable-libx264 --enable-shared
  libavutil      56. 22.100 / 56. 22.100
  libavcodec     58. 35.100 / 58. 35.100
  libavformat    58. 20.100 / 58. 20.100
  libavdevice    58.  5.100 / 58.  5.100
  libavfilter     7. 40.101 /  7. 40.101
  libavresample   4.  0.  0 /  4.  0.  0
  libswscale     5.  3.100 /  5.  3.100
  libswresample   3.  3.100 /  3.  3.100
  libpostproc    55.  3.100 / 55.  3.100
Input #0, matroska,webm, from 'railgun.mkv':
  Metadata:
    COMPATIBLE_BRANDS: iso6avc1mp41
    MAJOR_BRAND       : dash
    MINOR_VERSION     : 0
    ENCODER           : Lavf58.20.100
  Duration: 00:01:28.60, start: -0.007000, bitrate: 1345 kb/s
    Stream #0:0: Video: h264 (Main), yuv420p(progressive), 854x480 [SAR 1:1 DAR 427:240], 29.97 fps
, 29.97 tbr, 1k tbn, 59.94 tbc (default)
    Metadata:
      HANDLER_NAME     : VideoHandler
      DURATION         : 00:01:28.054000000
    Stream #0:1(eng): Audio: opus, 48000 Hz, stereo, fltp (default)
    Metadata:
      DURATION         : 00:01:28.601000000
 77.29 A-V: -0.031 fd=  0 aq=  20KB vq=  162KB sq=  0B f=0/0
wrg@wrg-900X5N:~/study/live_stream$
```



```

wrg@wrg-900X5N:~/study/live_stream$ ffmpeg -i railgun.mkv railgun.mp4
ffmpeg version 4.1.1-0york1~16.04 Copyright (c) 2000-2019 the FFmpeg developers
  built with gcc 5.4.0 (Ubuntu 5.4.0-6ubuntu1~16.04.11) 20160609
  configuration: --prefix=/usr --extra-version='0york1~16.04' --toolchain=hardened --libdir=/usr/li
b/x86_64-linux-gnu --incdir=/usr/include/x86_64-linux-gnu --arch=amd64 --enable-gpl --disable-strip
ping --enable-avresample --disable-filter=resample --enable-avisynth --enable-gnutls --enable-ladsp
a --enable-libaom --enable-libass --enable-libbluray --enable-libbs2b --enable-libcaca --enable-lib
cdio --enable-libcodec2 --enable-libflite --enable-libfontconfig --enable-libfreetype --enable-libf
ribidi --enable-libgme --enable-libgsm --enable-libjack --enable-libmp3lame --enable-libmysofa --en
able-libopenjpeg --enable-libopenmpt --enable-libopus --enable-libpulse --enable-libsvg --enable-l
ibrubberband --enable-libshine --enable-libsnappy --enable-libsoxr --enable-libspeex --enable-libss
h --enable-libtheora --enable-libtwolame --enable-libvidstab --enable-libvorbis --enable-libvpx --e
nable-libwavpack --enable-libwebp --enable-libx265 --enable-libxml2 --enable-libxvid --enable-libzm
q --enable-libzvb1 --enable-lv2 --enable-omx --enable-openal --enable-opengl --enable-sdl2 --enable
-nonfree --enable-libfdk-aac --enable-libdc1394 --enable-libdrm --enable-libiec61883 --enable-chrom
aprint --enable-frei0r --enable-libx264 --enable-shared
  libavutil      56. 22.100 / 56. 22.100
  libavcodec     58. 35.100 / 58. 35.100
  libavformat    58. 20.100 / 58. 20.100
  libavdevice    58.  5.100 / 58.  5.100
  libavfilter     7. 40.101 /  7. 40.101
  libavresample   4.  0.  0 /  4.  0.  0
  libswscale     5.  3.100 /  5.  3.100
  libswresample   3.  3.100 /  3.  3.100
  libpostproc    55.  3.100 / 55.  3.100
Input #0, matroska,webm, from 'railgun.mkv':
  Metadata:
    COMPATIBLE_BRANDS: iso6avc1mp41
    MAJOR_BRAND       : dash
    MINOR_VERSION     : 0
    ENCODER           : Lavf58.20.100
  Duration: 00:01:28.60, start: -0.007000, bitrate: 1345 kb/s
    Stream #0:0: Video: h264 (Main), yuv420p(progressive), 854x480 [SAR 1:1 DAR 427:240], 29.97 fps
, 29.97 tbr, 1k tbn, 59.94 tbc (default)
    Metadata:
      HANDLER_NAME    : VideoHandler
      DURATION        : 00:01:28.054000000
    Stream #0:1(eng): Audio: opus, 48000 Hz, stereo, fltp (default)
    Metadata:
      DURATION        : 00:01:28.601000000
Stream mapping:
  Stream #0:0 -> #0:0 (h264 (native) -> h264 (libx264))
  Stream #0:1 -> #0:1 (opus (native) -> aac (native))
Press [q] to stop, [?] for help

```

```
DURATION          : 00:01:28.601000000
Stream mapping:
  Stream #0:0 -> #0:0 (h264 (native) -> h264 (libx264))
  Stream #0:1 -> #0:1 (opus (native) -> aac (native))
Press [q] to stop, [?] for help
[libx264 @ 0x5622db0d6d80] using SAR=1/1
[libx264 @ 0x5622db0d6d80] using cpu capabilities: MMX2 SSE2Fast SSSE3 SSE4.2 AVX FMA3 BMI2 AVX2
[libx264 @ 0x5622db0d6d80] profile High, level 3.1
[libx264 @ 0x5622db0d6d80] 264 - core 155 r2917 0a84d98 - H.264/MPEG-4 AVC codec - Copyleft 2003-20
18 - http://www.videolan.org/x264.html - options: cabac=1 ref=3 deblock=1:0:0 analyse=0x3:0x113 me=
hex subme=7 psy=1 psy_rd=1.00:0.00 mixed_ref=1 me_range=16 chroma_me=1 trellis=1 8x8dct=1 cqm=0 dea
dzone=21,11 fast_pskip=1 chroma_qp_offset=-2 threads=6 lookahead_threads=1 sliced_threads=0 nr=0 de
cimate=1 interlaced=0 bluray_compat=0 constrained_intra=0 bframes=3 b_pyramid=2 b_adapt=1 b_bias=0
direct=1 weightb=1 open_gop=0 weightp=2 keyint=250 keyint_min=25 scenecut=40 intra_refresh=0 rc_loo
kahead=40 rc=crf mbtree=1 crf=23.0 qcomp=0.60 qpmin=0 qpmax=69 qpstep=4 ip_ratio=1.40 aq=1:1.00
Output #0, mp4, to 'railgun.mp4':
  Metadata:
    COMPATIBLE_BRANDS: iso6avc1mp41
    MAJOR_BRAND       : dash
    MINOR_VERSION     : 0
    encoder           : Lavf58.20.100
  Stream #0:0: Video: h264 (libx264) (avc1 / 0x31637661), yuv420p, 854x480 [SAR 1:1 DAR 427:240],
q=-1--1, 29.97 fps, 30k tbn, 29.97 tbc (default)
  Metadata:
    HANDLER_NAME      : VideoHandler
    DURATION          : 00:01:28.054000000
    encoder           : Lavc58.35.100 libx264
  Side data:
    cpb: bitrate max/min/avg: 0/0/0 buffer size: 0 vbv_delay: -1
  Stream #0:1(eng): Audio: aac (LC) (mp4a / 0x6134706D), 48000 Hz, stereo, fltp, 128 kb/s (default)
  Metadata:
    DURATION          : 00:01:28.601000000
    encoder           : Lavc58.35.100 aac
frame= 2639 fps= 94 q=-1.0 Lsize=   18285kB time=00:01:28.59 bitrate=1690.7kbits/s speed=3.15x
video:16809kB audio:1381kB subtitle:0kB other streams:0kB global headers:0kB muxing overhead: 0.521
135%
[libx264 @ 0x5622db0d6d80] frame I:12    Avg QP:21.00    size: 58930
[libx264 @ 0x5622db0d6d80] frame P:861   Avg QP:24.23    size: 14214
[libx264 @ 0x5622db0d6d80] frame B:1766  Avg QP:28.94    size:  2416
[libx264 @ 0x5622db0d6d80] consecutive B-frames:  5.5% 12.5%  9.7% 72.3%
[libx264 @ 0x5622db0d6d80] mb I  I16..4: 12.0% 60.1% 28.0%
[libx264 @ 0x5622db0d6d80] mb P  I16..4:  4.7%  6.2%  2.7% P16..4: 39.1% 21.2% 12.9%  0.0%  0.0%
skip:13.3%
```

```

Stream #0:0: Video: h264 (libx264) (avc1 / 0x31637661), yuv420p, 854x480 [SAR 1:1 DAR 427:240],
q=-1--1, 29.97 fps, 30k tbn, 29.97 tbc (default)
Metadata:
  HANDLER_NAME       : VideoHandler
  DURATION            : 00:01:28.054000000
  encoder             : Lavc58.35.100 libx264
Side data:
  cpb: bitrate max/min/avg: 0/0/0 buffer size: 0 vbv_delay: -1
Stream #0:1(eng): Audio: aac (LC) (mp4a / 0x6134706D), 48000 Hz, stereo, fltp, 128 kb/s (default)
Metadata:
  DURATION            : 00:01:28.601000000
  encoder             : Lavc58.35.100 aac
frame= 2639 fps= 94 q=-1.0 Lsize=   18285kB time=00:01:28.59 bitrate=1690.7kbits/s speed=3.15x
video:16809kB audio:1381kB subtitle:0kB other streams:0kB global headers:0kB muxing overhead: 0.521
135%
[libx264 @ 0x5622db0d6d80] frame I:12    Avg QP:21.00    size: 58930
[libx264 @ 0x5622db0d6d80] frame P:861    Avg QP:24.23    size: 14214
[libx264 @ 0x5622db0d6d80] frame B:1766    Avg QP:28.94    size:  2416
[libx264 @ 0x5622db0d6d80] consecutive B-frames:  5.5% 12.5%  9.7% 72.3%
[libx264 @ 0x5622db0d6d80] mb I  I16..4: 12.0% 60.1% 28.0%
[libx264 @ 0x5622db0d6d80] mb P  I16..4:  4.7%  6.2%  2.7%  P16..4: 39.1% 21.2% 12.9%  0.0%  0.0%
skip:13.3%
[libx264 @ 0x5622db0d6d80] mb B  I16..4:  0.2%  0.3%  0.2%  B16..8: 45.1%  7.3%  1.4% direct: 1.0%
skip:44.5% L0:42.5% L1:47.1% BI:10.4%
[libx264 @ 0x5622db0d6d80] 8x8 transform intra:46.4% inter:46.4%
[libx264 @ 0x5622db0d6d80] coded y,uvDC,uvAC intra: 45.0% 51.0% 13.4% inter: 14.8% 9.6% 0.1%
[libx264 @ 0x5622db0d6d80] i16 v,h,dc,p: 13% 43% 12% 31%
[libx264 @ 0x5622db0d6d80] i8 v,h,dc,ddl,ddr,vr,hd,vl,hu: 19% 25% 27%  4%  5%  5%  6%  4%  6%
[libx264 @ 0x5622db0d6d80] i4 v,h,dc,ddl,ddr,vr,hd,vl,hu: 17% 30% 18%  5%  7%  6%  7%  5%  6%
[libx264 @ 0x5622db0d6d80] i8c dc,h,v,p: 51% 30% 12%  6%
[libx264 @ 0x5622db0d6d80] Weighted P-Frames: Y:19.7% UV:5.3%
[libx264 @ 0x5622db0d6d80] ref P L0: 66.0% 18.8% 11.6%  3.3%  0.4%
[libx264 @ 0x5622db0d6d80] ref B L0: 91.1%  7.8%  1.1%
[libx264 @ 0x5622db0d6d80] ref B L1: 97.3%  2.7%
[libx264 @ 0x5622db0d6d80] kb/s:1563.77
[aac @ 0x5622db094d80] Qavg: 983.456
wrg@wrg-900X5N:~/study/live_stream$ clear

wrg@wrg-900X5N:~/study/live_stream$ ls
railgun.mkv  railgun.mp4  star2_zerg.mp4
wrg@wrg-900X5N:~/study/live_stream$

```



```

wrg@wrg-900X5N:~/study/live_stream$ ls
railgun.mkv railgun.mp4 star2_zerg.mp4
wrg@wrg-900X5N:~/study/live_stream$ ffplay railgun.mp4
ffplay version 4.1.1-0york1~16.04 Copyright (c) 2003-2019 the FFmpeg developers
  built with gcc 5.4.0 (Ubuntu 5.4.0-6ubuntu1~16.04.11) 20160609
  configuration: --prefix=/usr --extra-version='0york1~16.04' --toolchain=hardened --libdir=/usr/li
b/x86_64-linux-gnu --incdir=/usr/include/x86_64-linux-gnu --arch=amd64 --enable-gpl --disable-strip
ping --enable-avresample --enable-filter --enable-fs --enable-gnutls --enable-ladsp
a --enable-libaom --enable-libbrotli --enable-libcaca --enable-libcdio --enable-libcodecs2 --enable-libc
dio --enable-libcodecs2 --enable-libcdda --enable-libcddb --enable-libcinepack --enable-libcmin --enable-libc
ribidi --enable-libgme --enable-libgsm --enable-libgstreamer --enable-libgstreamer1.0 --enable-libgstreamer
able-libopenjpeg --enable-libopenm2 --enable-libopus --enable-librtmp --enable-librubberband --enable-libr
ibrubberband --enable-librubberband --enable-librubberband --enable-librubberband --enable-librubberband
h --enable-libtheora --enable-libtheora --enable-libtheora --enable-libtheora --enable-libtheora --enable-lib
nable-libwavpack --enable-libwavpack --enable-libwavpack --enable-libwavpack --enable-libwavpack --enable-lib
q --enable-libzvbi --enable-libzvbi --enable-libzvbi --enable-libzvbi --enable-libzvbi --enable-libzvbi --ena
-nonfree --enable-libfdk --enable-libfdk --enable-libfdk --enable-libfdk --enable-libfdk --enable-libfdk --ena
aprint --enable-frei0r --enable-frei0r --enable-frei0r --enable-frei0r --enable-frei0r --enable-frei0r --ena
libavutil      56. 22. 0. /usr/lib/x86_64-linux-gnu/libavutil.so.56
libavcodec     58. 35. 0. /usr/lib/x86_64-linux-gnu/libavcodec.so.58
libavformat    58. 20. 0. /usr/lib/x86_64-linux-gnu/libavformat.so.58
libavdevice    58.  5. 0. /usr/lib/x86_64-linux-gnu/libavdevice.so.58
libavfilter     7. 40. 0. /usr/lib/x86_64-linux-gnu/libavfilter.so.7
libavresample   4.  0. 0. /usr/lib/x86_64-linux-gnu/libavresample.so.4
libswscale     5.  3. 0. /usr/lib/x86_64-linux-gnu/libswscale.so.5
libswresample   3.  3. 0. /usr/lib/x86_64-linux-gnu/libswresample.so.3
libpostproc    55.  3. 0. /usr/lib/x86_64-linux-gnu/libpostproc.so.55
Input #0, mov,mp4,m4a,3gp,3g2,mj2, from 'railgun.mp4':
  Metadata:
    major_brand      : isom
    minor_version    : 512
    compatible_brands: isomiso2avc1mp41
    encoder          : Lavf58.20.100
  Duration: 00:01:28.61, start: 0.000000, bitrate: 1690 kb/s
    Stream #0:0(und): Video: h264 (High) (avc1 / 0x31637661), yuv420p, 854x480 [SAR 1:1 DAR 427:240
], 1563 kb/s, 29.97 fps, 29.97 tbr, 30k tbn, 59.94 tbc (default)
    Metadata:
      handler_name    : VideoHandler
    Stream #0:1(eng): Audio: aac (LC) (mp4a / 0x6134706D), 48000 Hz, stereo, fltp, 127 kb/s (default)
    Metadata:
      handler_name    : SoundHandler
[ 15.12 A-V: -0.025 fd= 0 aq= 20KB vq= 177KB sq= 0B f=0/0

```



```
wrg@wrg-900X5N:~/study/live_stream$ ffmpeg -codecs
ffmpeg version 4.1.1-0york1~16.04 Copyright (c) 2000-2019 the FFmpeg developers
  built with gcc 5.4.0 (Ubuntu 5.4.0-6ubuntu1~16.04.11) 20160609
  configuration: --prefix=/usr --extra-version='0york1~16.04' --toolchain=hardened --libdir=/usr/li
b/x86_64-linux-gnu --incdir=/usr/include/x86_64-linux-gnu --arch=amd64 --enable-gpl --disable-strip
ping --enable-avresample --disable-filter=resample --enable-avisynth --enable-gnutls --enable-ladsp
a --enable-libaom --enable-libass --enable-libbluray --enable-libbs2b --enable-libcaca --enable-lib
cdio --enable-libcodec2 --enable-libflite --enable-libfontconfig --enable-libfreetype --enable-libf
ribidi --enable-libgme --enable-libgsm --enable-libjack --enable-libmp3lame --enable-libmysofa --en
able-libopenjpeg --enable-libopenmpt --enable-libopus --enable-libpulse --enable-librsvg --enable-l
ibrubberband --enable-libshine --enable-lbsnappy --enable-libsoxr --enable-lbspeex --enable-libss
h --enable-libtheora --enable-libtwolame --enable-libvidstab --enable-libvorbis --enable-libvpx --e
nable-libwavpack --enable-libwebp --enable-libx265 --enable-libxml2 --enable-libxvid --enable-libzm
q --enable-libzvbi --enable-lv2 --enable-omx --enable-opengl --enable-sdl2 --enable
-nonfree --enable-libfdk-aac --enable-libdc1394 --enable-libdrm --enable-libiec61883 --enable-chrom
aprint --enable-frei0r --enable-libx264 --enable-shared
  libavutil      56. 22.100 / 56. 22.100
  libavcodec     58. 35.100 / 58. 35.100
  libavformat    58. 20.100 / 58. 20.100
  libavdevice    58.  5.100 / 58.  5.100
  libavfilter     7. 40.101 /  7. 40.101
  libavresample   4.  0.  0 /  4.  0.  0
  libswscale     5.  3.100 /  5.  3.100
  libswresample   3.  3.100 /  3.  3.100
  libpostproc    55.  3.100 / 55.  3.100
```

#### Codecs:

```
D..... = Decoding supported
.E.... = Encoding supported
..V... = Video codec
..A... = Audio codec
..S... = Subtitle codec
...I.. = Intra frame-only codec
....L. = Lossy compression
.....S = Lossless compression
-----
D.VI.S 012v          Uncompressed 4:2:2 10-bit
D.V.L. 4xm           4X Movie
D.VI.S 8bps          QuickTime 8BPS video
.EVIL. a64_multi      Multicolor charset for Commodore 64 (encoders: a64multi )
.EVIL. a64_multi5     Multicolor charset for Commodore 64, extended with 5th color (colram)
(encoders: a64multi5 )
D.V..S aasc          Autodesk RLE
D.VIL. aic           Apple Intermediate Codec
DEVI.S alias_pix     Alias/Wavefront PIX image
```

```
wrg@wrg-900X5N:~/study/live_stream$ ffmpeg -codecs | grep h264
ffmpeg version 4.1.1-0york1~16.04 Copyright (c) 2000-2019 the FFmpeg developers
  built with gcc 5.4.0 (Ubuntu 5.4.0-6ubuntu1~16.04.11) 20160609
  configuration: --prefix=/usr --extra-version='0york1~16.04' --toolchain=hardened --libdir=/usr/li
b/x86_64-linux-gnu --incdir=/usr/include/x86_64-linux-gnu --arch=amd64 --enable-gpl --disable-strip
ping --enable-avresample --disable-filter=resample --enable-avisynth --enable-gnutls --enable-ladsp
a --enable-libaom --enable-libass --enable-libbluray --enable-libbs2b --enable-libcaca --enable-lib
cdio --enable-libcodec2 --enable-libflite --enable-libfontconfig --enable-libfreetype --enable-libf
ribidi --enable-libgme --enable-libgsm --enable-libjack --enable-libmp3lame --enable-libmysofa --en
able-libopenjpeg --enable-libopenmpt --enable-libopus --enable-libpulse --enable-libsvg --enable-l
ibrubberband --enable-libshine --enable-lbsnappy --enable-libsoxr --enable-lbspeex --enable-libss
h --enable-libtheora --enable-libtwolame --enable-libvidstab --enable-libvorbis --enable-libvpx --e
nable-libwavpack --enable-libwebp --enable-libx265 --enable-libxml2 --enable-libxvid --enable-libzm
q --enable-libzvbi --enable-lv2 --enable-omx --enable-openal --enable-opengl --enable-sdl2 --enable
-nonfree --enable-libfdk-aac --enable-libdc1394 --enable-libdrm --enable-libiec61883 --enable-chrom
aprint --enable-frei0r --enable-libx264 --enable-shared
  libavutil      56. 22.100 / 56. 22.100
  libavcodec     58. 35.100 / 58. 35.100
  libavformat    58. 20.100 / 58. 20.100
  libavdevice    58.  5.100 / 58.  5.100
  libavfilter     7. 40.101 /  7. 40.101
  libavresample   4.  0.  0 /  4.  0.  0
  libswscale     5.  3.100 /  5.  3.100
  libswresample   3.  3.100 /  3.  3.100
  libpostproc    55.  3.100 / 55.  3.100
  DEV.LS h264 H.264 / AVC / MPEG-4 AVC / MPEG-4 part 10 (decoders: h264 h264_crystal
hd h264_v4l2m2m ) (encoders: libx264 libx264rgb h264_omx h264_v4l2m2m h264_vaapi )
wrg@wrg-900X5N:~/study/live_stream$
```



```
wrg@wrg-900X5N:~/study/live_stream$ ffmpeg -codecs | grep v4l2
ffmpeg version 4.1.1-0york1~16.04 Copyright (c) 2000-2019 the FFmpeg developers
  built with gcc 5.4.0 (Ubuntu 5.4.0-6ubuntu1~16.04.11) 20160609
  configuration: --prefix=/usr --extra-version='0york1~16.04' --toolchain=hardened --libdir=/usr/lib/x86_64-linux-gnu --incdir=/usr/include/x86_64-linux-gnu --arch=amd64 --enable-gpl --disable-strip
ping --enable-avresample --disable-filter=resample --enable-avisynth --enable-gnutls --enable-ladspa --enable-libaom --enable-libass --enable-libbluray --enable-libbs2b --enable-libcaca --enable-libcdio --enable-libcodec2 --enable-libflite --enable-libfontconfig --enable-libfreetype --enable-libfribidi --enable-libgme --enable-libgsm --enable-libjack --enable-libmp3lame --enable-libmysofa --enable-libopenjpeg --enable-libopenmpt --enable-libopus --enable-libpulse --enable-librsvg --enable-librubberband --enable-libshine --enable-libsnappy --enable-libsoxr --enable-libspeex --enable-libssh --enable-libtheora --enable-libtwolame --enable-libvidstab --enable-libvorbis --enable-libvpx --enable-libwavpack --enable-libwebp --enable-libx265 --enable-libxml2 --enable-libxvid --enable-libzmq --enable-libzvbi --enable-lv2 --enable-omx --enable-openal --enable-opengl --enable-sdl2 --enable-nonfree --enable-libfdk-aac --enable-libdc1394 --enable-libdrm --enable-libiec61883 --enable-chromaprint --enable-frei0r --enable-libx264 --enable-shared
  libavutil      56. 22.100 / 56. 22.100
  libavcodec     58. 35.100 / 58. 35.100
  libavformat    58. 20.100 / 58. 20.100
  libavdevice    58.  5.100 / 58.  5.100
  libavfilter     7. 40.101 /  7. 40.101
  libavresample   4.  0.  0 /  4.  0.  0
  libswscale     5.  3.100 /  5.  3.100
  libswresample   3.  3.100 /  3.  3.100
  libpostproc    55.  3.100 / 55.  3.100
  DEV.L. h263      H.263 / H.263-1996, H.263+ / H.263-1998 / H.263 version 2 (decoders: h263 h263_v4l2m2m ) (encoders: h263 h263_v4l2m2m )
  DEV.LS h264      H.264 / AVC / MPEG-4 AVC / MPEG-4 part 10 (decoders: h264 h264_crystalhd h264_v4l2m2m ) (encoders: libx264 libx264rgb h264_omx h264_v4l2m2m h264_vaapi )
  DEV.L. mpeg1video MPEG-1 video (decoders: mpeg1video mpeg1_v4l2m2m )
  DEV.L. mpeg2video MPEG-2 video (decoders: mpeg2video mpegvideo mpeg2_crystalhd mpeg2_v4l2m2m ) (encoders: mpeg2video mpeg2_vaapi )
  DEV.L. mpeg4      MPEG-4 part 2 (decoders: mpeg4 mpeg4_crystalhd mpeg4_v4l2m2m ) (encoders: mpeg4 libxvid mpeg4_v4l2m2m )
  D.V.L. vc1        SMPT E VC-1 (decoders: vc1 vc1_crystalhd vc1_v4l2m2m )
  DEV.L. vp8        On2 VP8 (decoders: vp8 vp8_v4l2m2m libvpx ) (encoders: libvpx vp8_v4l2m2m vp8_vaapi )
wrg@wrg-900X5N:~/study/live_stream$
```

```
wrg@wrg-900X5N:~/study/live_stream$ ffmpeg -i railgun.mkv -c:v libx264 railgun.mp4
ffmpeg version 4.1.1-0york1~16.04 Copyright (c) 2000-2019 the FFmpeg developers
  built with gcc 5.4.0 (Ubuntu 5.4.0-6ubuntu1~16.04.11) 20160609
  configuration: --prefix=/usr --extra-version='0york1~16.04' --toolchain=hardened --libdir=/usr/lib/x86_64-linux-gnu --incdir=/usr/include/x86_64-linux-gnu --arch=amd64 --enable-gpl --disable-strip
ping --enable-avresample --disable-filter=resample --enable-avisynth --enable-gnutls --enable-ladspa --enable-libaom --enable-libass --enable-libbluray --enable-libbs2b --enable-libcaca --enable-libcdio --enable-libcodec2 --enable-libflite --enable-libfontconfig --enable-libfreetype --enable-libfribidi --enable-libgme --enable-libgsm --enable-libjack --enable-libmp3lame --enable-libmysofa --enable-libopenjpeg --enable-libopenmpt --enable-libopus --enable-libpulse --enable-librsvg --enable-librubberband --enable-libshine --enable-libsnappy --enable-libsoxr --enable-libspeex --enable-libssh --enable-libtheora --enable-libtwolame --enable-libvidstab --enable-libvorbis --enable-libvpx --enable-libwavpack --enable-libwebp --enable-libx265 --enable-libxml2 --enable-libxvid --enable-libzmq --enable-libzvbi --enable-lv2 --enable-omx --enable-openal --enable-opengl --enable-sdl2 --enable-nonfree --enable-libfdk-aac --enable-libdc1394 --enable-libdrm --enable-libiec61883 --enable-chromaprint --enable-frei0r --enable-libx264 --enable-shared
  libavutil      56. 22.100 / 56. 22.100
  libavcodec     58. 35.100 / 58. 35.100
  libavformat    58. 20.100 / 58. 20.100
  libavdevice    58.  5.100 / 58.  5.100
  libavfilter     7. 40.101 /  7. 40.101
  libavresample   4.  0.  0 /  4.  0.  0
  libswscale     5.  3.100 /  5.  3.100
  libswresample   3.  3.100 /  3.  3.100
  libpostproc    55.  3.100 / 55.  3.100
Input #0, matroska,webm, from 'railgun.mkv':
  Metadata:
    COMPATIBLE_BRANDS: iso6avc1mp41
    MAJOR_BRAND       : dash
    MINOR_VERSION     : 0
    ENCODER           : Lavf58.20.100
  Duration: 00:01:28.60, start: -0.007000, bitrate: 1345 kb/s
    Stream #0:0: Video: h264 (Main), yuv420p(progressive), 854x480 [SAR 1:1 DAR 427:240], 29.97 fps, 29.97 tbr, 1k tbn, 59.94 tbc (default)
    Metadata:
      HANDLER_NAME     : VideoHandler
      DURATION         : 00:01:28.054000000
    Stream #0:1(eng): Audio: opus, 48000 Hz, stereo, fltp (default)
    Metadata:
      DURATION         : 00:01:28.601000000
File 'railgun.mp4' already exists. Overwrite ? [y/N] y
```

```
wrg@wrg-900X5N:~/study/live_stream$ ffmpeg -codecs | grep mp3
ffmpeg version 4.1.1-0york1~16.04 Copyright (c) 2000-2019 the FFmpeg developers
  built with gcc 5.4.0 (Ubuntu 5.4.0-6ubuntu1~16.04.11) 20160609
  configuration: --prefix=/usr --extra-version='0york1~16.04' --toolchain=hardened --libdir=/usr/li
b/x86_64-linux-gnu --incdir=/usr/include/x86_64-linux-gnu --arch=amd64 --enable-gpl --disable-strip
ping --enable-avresample --disable-filter=resample --enable-avisynth --enable-gnutls --enable-ladsp
a --enable-libaom --enable-libass --enable-libbluray --enable-libbs2b --enable-libcaca --enable-lib
cdio --enable-libcodec2 --enable-libflite --enable-libfontconfig --enable-libfreetype --enable-libf
ribidi --enable-libgme --enable-libgsm --enable-libjack --enable-libmp3lame --enable-libmysofa --en
able-libopenjpeg --enable-libopenmpt --enable-libopus --enable-libpulse --enable-librsvg --enable-l
ibrubberband --enable-libshine --enable-libsnappp --enable-libsoxr --enable-libspeex --enable-libss
h --enable-libtheora --enable-libtwolame --enable-libvidstab --enable-libvorbis --enable-libvpx --e
nable-libwavpack --enable-libwebp --enable-libx265 --enable-libxml2 --enable-libxvid --enable-libzm
q --enable-libzvb --enable-lv2 --enable-omx --enable-openal --enable-opengl --enable-sdl2 --enable
-nonfree --enable-libfdk-aac --enable-libdc1394 --enable-libdrm --enable-libiec61883 --enable-chrom
aprint --enable-frei0r --enable-libx264 --enable-shared
  libavutil      56. 22.100 / 56. 22.100
  libavcodec     58. 35.100 / 58. 35.100
  libavformat    58. 20.100 / 58. 20.100
  libavdevice    58.  5.100 / 58.  5.100
  libavfilter     7. 40.101 /  7. 40.101
  libavresample   4.  0.  0 /  4.  0.  0
  libswscale     5.  3.100 /  5.  3.100
  libswresample   3.  3.100 /  3.  3.100
  libpostproc    55.  3.100 / 55.  3.100
  DEA.L. mp3      MP3 (MPEG audio layer 3) (decoders: mp3float mp3 ) (encoders: libmp3la
me libshine )
  D.A.L. mp3adu   ADU (Application Data Unit) MP3 (MPEG audio layer 3) (decoders: mp3adu
float mp3adu )
  D.A.L. mp3on4   MP3onMP4 (decoders: mp3on4float mp3on4 )
wrg@wrg-900X5N:~/study/live_stream$ █
```

```
wrg@wrg-900X5N:~/study/live_stream$ ffmpeg -i railgun.mkv -codec:a libmp3lame railgun.mp4
ffmpeg version 4.1.1-0york1~16.04 Copyright (c) 2000-2019 the FFmpeg developers
  built with gcc 5.4.0 (Ubuntu 5.4.0-6ubuntu1~16.04.11) 20160609
  configuration: --prefix=/usr --extra-version='0york1~16.04' --toolchain=hardened --libdir=/usr/lib/x86_64-linux-gnu --incdir=/usr/include/x86_64-linux-gnu --arch=amd64 --enable-gpl --disable-strip
ping --enable-avresample --disable-filter=resample --enable-avisynth --enable-gnutls --enable-ladspa
--enable-libaom --enable-libass --enable-libbluray --enable-libbs2b --enable-libcaca --enable-libcdio
--enable-libcodec2 --enable-libflite --enable-libfontconfig --enable-libfreetype --enable-libfribidi
--enable-libgme --enable-libgsm --enable-libjack --enable-libmp3lame --enable-libmysofa --enable-libopenjpeg
--enable-libopenmpt --enable-libopus --enable-libpulse --enable-librsvg --enable-librubberband --enable-libshine
--enable-libsnappy --enable-libsoxr --enable-libspeex --enable-libssh --enable-libtheora --enable-libtwolame
--enable-libvidstab --enable-libvorbis --enable-libvpx --enable-libwavpack --enable-libwebp --enable-libx265
--enable-libxml2 --enable-libxvid --enable-libzmq --enable-libzvbi --enable-lv2 --enable-omx --enable-openal
--enable-opengl --enable-sdl2 --enable-nonfree --enable-libfdk-aac --enable-libdc1394 --enable-libdrm --enable-libiec61883
--enable-chromaprint --enable-frei0r --enable-libx264 --enable-shared
  libavutil      56. 22.100 / 56. 22.100
  libavcodec     58. 35.100 / 58. 35.100
  libavformat    58. 20.100 / 58. 20.100
  libavdevice    58.  5.100 / 58.  5.100
  libavfilter     7. 40.101 /  7. 40.101
  libavresample   4.  0.  0 /  4.  0.  0
  libswscale     5.  3.100 /  5.  3.100
  libswresample   3.  3.100 /  3.  3.100
  libpostproc    55.  3.100 / 55.  3.100
Input #0, matroska,webm, from 'railgun.mkv':
  Metadata:
    COMPATIBLE_BRANDS: iso6avc1mp41
    MAJOR_BRAND       : dash
    MINOR_VERSION     : 0
    ENCODER           : Lavf58.20.100
  Duration: 00:01:28.60, start: -0.007000, bitrate: 1345 kb/s
    Stream #0:0: Video: h264 (Main), yuv420p(progressive), 854x480 [SAR 1:1 DAR 427:240], 29.97 fps
    , 29.97 tbr, 1k tbn, 59.94 tbc (default)
    Metadata:
      HANDLER_NAME     : VideoHandler
      DURATION         : 00:01:28.054000000
    Stream #0:1(eng): Audio: opus, 48000 Hz, stereo, fltp (default)
    Metadata:
      DURATION         : 00:01:28.601000000
File 'railgun.mp4' already exists. Overwrite ? [y/N] y
```

```
wrg@wrg-900X5N:~/study/live_stream$ ffmpeg -i railgun.mkv -c:v h264 -vf scale=320:240 -c:a libmp3lame railgun.mp4
ffmpeg version 4.1.1-0york1~16.04 Copyright (c) 2000-2019 the FFmpeg developers
  built with gcc 5.4.0 (Ubuntu 5.4.0-6ubuntu1~16.04.11) 20160609
  configuration: --prefix=/usr --extra-version='0york1~16.04' --toolchain=hardened --libdir=/usr/lib/x86_64-linux-gnu --incdir=/usr/include/x86_64-linux-gnu --arch=amd64 --enable-gpl --disable-strip
ping --enable-avresample --disable-filter=resample --enable-avisynth --enable-gnutls --enable-ladspa --enable-libaom --enable-libass --enable-libbluray --enable-libbs2b --enable-libcaca --enable-libcdio --enable-libcodec2 --enable-libflite --enable-libfontconfig --enable-libfreetype --enable-libfribidi --enable-libgme --enable-libgsm --enable-libjack --enable-libmp3lame --enable-libmysofa --enable-libopenjpeg --enable-libopenmpt --enable-libopus --enable-libpulse --enable-librsvg --enable-librubberband --enable-libshine --enable-libsnappy --enable-libsoxr --enable-libspeex --enable-libssh --enable-libtheora --enable-libtwolame --enable-libvidstab --enable-libvorbis --enable-libvpx --enable-libwavpack --enable-libwebp --enable-libx265 --enable-libxml2 --enable-libxvid --enable-libzmq --enable-libzvbi --enable-lv2 --enable-omx --enable-opengl --enable-sdl2 --enable-nonfree --enable-libfdk-aac --enable-libdc1394 --enable-libdrm --enable-libiec61883 --enable-chromaprint --enable-frei0r --enable-libx264 --enable-shared
  libavutil      56. 22.100 / 56. 22.100
  libavcodec     58. 35.100 / 58. 35.100
  libavformat    58. 20.100 / 58. 20.100
  libavdevice    58.  5.100 / 58.  5.100
  libavfilter    7. 40.101 / 7. 40.101
  libavresample  4.  0.  0 / 4.  0.  0
  libswscale     5.  3.100 / 5.  3.100
  libswresample  3.  3.100 / 3.  3.100
  libpostproc   55.  3.100 / 55.  3.100
Input #0, matroska,webm, from 'railgun.mkv':
  Metadata:
    COMPATIBLE_BRANDS: iso6avc1mp41
    MAJOR_BRAND       : dash
    MINOR_VERSION     : 0
    ENCODER           : Lavf58.20.100
  Duration: 00:01:28.60, start: -0.007000, bitrate: 1345 kb/s
    Stream #0:0: Video: h264 (Main), yuv420p(progressive), 854x480 [SAR 1:1 DAR 427:240], 29.97 fps, 29.97 tbr, 1k tbn, 59.94 tbc (default)
    Metadata:
      HANDLER_NAME     : VideoHandler
      DURATION         : 00:01:28.054000000
    Stream #0:1(eng): Audio: opus, 48000 Hz, stereo, fltp (default)
    Metadata:
      DURATION         : 00:01:28.601000000
File 'railgun.mp4' already exists. Overwrite ? [y/N] y
```



```
[libx264 @ 0x55b36836ab80] ref P L0: 63.7% 18.3% 10.7% 6.6% 0.7%  
[libx264 @ 0x55b36836ab80] ref B L0: 88.3% 8.9% 2.8%  
[libx264 @ 0x55b36836ab80] ref B L1: 92.3% 7.7%  
[libx264 @ 0x55b36836ab80] kb/s:419.13
```

```
wrg@wrg-900X5N:~/study/live_stream$ ffplay railgun.mp4
```

```
ffplay version 4.1.1-0york1~16.04 Copyright (c) 2003-2019 the FFmpeg developers
```

```
built with gcc 5.4.0 (Ubuntu 5.4.0-6ubuntu1~16.04.11) 20160609
```

```
configuration: --prefix=/usr --extra-version='0york1~16.04' --toolchain=hardened --libdir=/usr/lib/x86_64-linux-gnu --incdir=/usr/include/x86_64-linux-gnu --arch=amd64 --enable-gpl --disable-strip  
ping --enable-avresample --disable-filter=resample --enable-avisynth --enable-gnutls --enable-ladspa  
a --enable-libaom --enable-libass --enable-libbluray --enable-libbs2b --enable-libcaca --enable-libcdio  
--enable-libcodec2 --enable-libflite --enable-libfontconfig --enable-libfreetype --enable-libfribidi  
--enable-libgme --enable-libgsm --enable-libjack --enable-libmp3lame --enable-libmysofa --enable-libopenjpeg  
--enable-libopenmpt --enable-libopus --enable-libpulse --enable-librsvg --enable-librubberband  
--enable-libshine --enable-lbsnappy --enable-libsoxr --enable-lbspeex --enable-libssh --enable-libtheora  
--enable-libtwolame --enable-libvidstab --enable-libvorbis --enable-libvpx --enable-libwavpack  
--enable-libwebp --enable-libx265 --enable-libxml2 --enable-libxvid --enable-libzmq --enable-libzvbi  
--enable-lv2 --enable-omx --enable-opengl --enable-sdl2 --enable-nonfree --enable-libfdk-aac --enable-libdc1394  
--enable-libdrm --enable-libiec61883 --enable-chromaprint --enable-frei0r --enable-libx264 --enable-libx265
```

```
libavutil      56. 22.100 / 56. 22.100  
libavcodec     58. 35.100 / 58. 35.100  
libavformat    58. 20.100 / 58. 20.100  
libavdevice    58.  5.100 / 58.  5.100  
libavfilter    7. 40.101 / 7. 40.101  
libavresample  4.  0.  0 / 4.  0.  0  
libswscale     5.  3.100 / 5.  3.100  
libswresample  3.  3.100 / 3.  3.100  
libpostproc   55.  3.100 / 55.  3.100
```

```
Input #0, mov,mp4,m4a,3gp,3g2,mj2, from 'railgun.'
```

```
Metadata:
```

```
major_brand      : isom  
minor_version    : 512  
compatible_brands: isomiso2avc1mp41  
encoder         : Lavf58.20.100
```

```
Duration: 00:01:28.62, start: 0.000000, bitrate: 551 kb/s
```

```
Stream #0:0(und): Video: h264 (High) (avc1 / 0x31637661), yuv420p, 320x240 [SAR 427:320 DAR 427:240], 419 kb/s, 29.97 fps, 29.97 tbr, 30k tbn, 59.94 tbc (default)
```

```
Metadata:
```

```
handler_name     : VideoHandler
```

```
Stream #0:1(eng): Audio: mp3 (mp4a / 0x6134706D), 48000 Hz, stereo, fltp, 128 kb/s (default)
```

```
Metadata:
```

```
handler_name     : SoundHandler
```

```
5.73 A-V: -0.020 fd= 0 aq= 0 KB vq= 46KB sq= 0B f=0/0
```





```
wrg@wrg-900X5N:~/study/live_stream$ ffmpeg -ss 1:10 -i railgun.mkv -t 10 -c:v h264 -vf scale=320:240 -c:a libmp3lame railgun.mp4
ffmpeg version 4.1.1-york1~16.04 Copyright (c) 2000-2019 the FFmpeg developers
  built with gcc 5.4.0 (Ubuntu 5.4.0-6ubuntu1~16.04.11) 20160609
  configuration: --prefix=/usr --extra-version='0york1~16.04' --toolchain=hardened --libdir=/usr/lib/x86_64-linux-gnu --incdir=/usr/include/x86_64-linux-gnu --arch=amd64 --enable-gpl --disable-strip --enable-avresample --disable-filter=resample --enable-avisynth --enable-gnutls --enable-ladspa --enable-libaom --enable-libass --enable-libbluray --enable-libbs2b --enable-libcaca --enable-libcdio --enable-libcodec2 --enable-libflite --enable-libfontconfig --enable-libfreetype --enable-libfribidi --enable-libgme --enable-libgsm --enable-libjack --enable-libmp3lame --enable-libmysofa --enable-libopenjpeg --enable-libopenmpt --enable-libopus --enable-libpulse --enable-librsvg --enable-librubberband --enable-libshine --enable-libsnappy --enable-libsoxr --enable-libspeex --enable-libssh --enable-libtheora --enable-libtwolame --enable-libvidstab --enable-libvorbis --enable-libvpx --enable-libwavpack --enable-libwebp --enable-libx265 --enable-libxml2 --enable-libxvid --enable-libzmq --enable-libzvbi --enable-lv2 --enable-omx --enable-opengl --enable-sdl2 --enable-nonfree --enable-libfdk-aac --enable-libdc1394 --enable-libdrm --enable-libiec61883 --enable-chromaprint --enable-frei0r --enable-libx264 --enable-shared
  libavutil      56. 22.100 / 56. 22.100
  libavcodec     58. 35.100 / 58. 35.100
  libavformat    58. 20.100 / 58. 20.100
  libavdevice    58.  5.100 / 58.  5.100
  libavfilter    7. 40.101 / 7. 40.101
  libavresample  4.  0.  0 / 4.  0.  0
  libswscale     5.  3.100 / 5.  3.100
  libswresample  3.  3.100 / 3.  3.100
  libpostproc   55.  3.100 / 55.  3.100
Input #0, matroska,webm, from 'railgun.mkv':
  Metadata:
    COMPATIBLE_BRANDS: iso6avc1mp41
    MAJOR_BRAND       : dash
    MINOR_VERSION     : 0
    ENCODER           : Lavf58.20.100
  Duration: 00:01:28.60, start: -0.007000, bitrate: 1345 kb/s
    Stream #0:0: Video: h264 (Main), yuv420p(progressive), 854x480 [SAR 1:1 DAR 427:240], 29.97 fps, 29.97 tbr, 1k tbn, 59.94 tbc (default)
  Metadata:
    HANDLER_NAME      : VideoHandler
    DURATION           : 00:01:28.054000000
    Stream #0:1(eng): Audio: opus, 48000 Hz, stereo, fltp (default)
  Metadata:
    DURATION           : 00:01:28.601000000
File 'railgun.mp4' already exists. Overwrite ? [y/N] y
```

```
wrg@wrg-900X5N:~/study/live_stream$ ffmpeg -i railgun.mkv -vf scale=1280:720 -vcodec libx264 -acodec aac -f stream_segment -segment_time 10 -segment_list index.m3u8 -segment_list_type m3u8 segment_%03d.ts
```

```
ffmpeg version 4.1.1-0york1~16.04 Copyright (c) 2000-2019 the FFmpeg developers
```

```
built with gcc 5.4.0 (Ubuntu 5.4.0-6ubuntu1~16.04.11) 20160609
```

```
configuration: --prefix=/usr --extra-version='0york1~16.04' --toolchain=hardened --libdir=/usr/lib/x86_64-linux-gnu --incdir=/usr/include/x86_64-linux-gnu --arch=amd64 --enable-gpl --disable-strip --enable-avresample --disable-filter=resample --enable-avisynth --enable-gnutls --enable-ladspa --enable-libaom --enable-libass --enable-libbluray --enable-libbs2b --enable-libcaca --enable-libcdio --enable-libcodec2 --enable-libflite --enable-libfontconfig --enable-libfreetype --enable-libfribidi --enable-libgme --enable-libgsm --enable-libjack --enable-libmp3lame --enable-libmysofa --enable-libopenjpeg --enable-libopenmpt --enable-libopus --enable-libpulse --enable-librsvg --enable-librubberband --enable-libshine --enable-libsnappy --enable-libsoxr --enable-libspeex --enable-libssh --enable-libtheora --enable-libtwolame --enable-libvidstab --enable-libvorbis --enable-libvpx --enable-libwavpack --enable-libwebp --enable-libx265 --enable-libxml2 --enable-libxvid --enable-libzmq --enable-libzvbi --enable-lv2 --enable-omx --enable-openal --enable-opengl --enable-sdl2 --enable-nonfree --enable-libfdk-aac --enable-libdc1394 --enable-libdrm --enable-libiec61883 --enable-chromaprint --enable-frei0r --enable-libx264 --enable-shared
```

```
libavutil      56. 22.100 / 56. 22.100
libavcodec     58. 35.100 / 58. 35.100
libavformat    58. 20.100 / 58. 20.100
libavdevice    58.  5.100 / 58.  5.100
libavfilter    7. 40.101 / 7. 40.101
libavresample  4.  0.  0 / 4.  0.  0
libswscale     5.  3.100 / 5.  3.100
libswresample  3.  3.100 / 3.  3.100
libpostproc   55.  3.100 / 55.  3.100
```

```
Input #0, matroska,webm, from 'railgun.mkv':
```

```
Metadata:
```

```
COMPATIBLE_BRANDS: iso6avc1mp41
MAJOR_BRAND       : dash
MINOR_VERSION     : 0
ENCODER           : Lavf58.20.100
```

```
Duration: 00:01:28.60, start: -0.007000, bitrate: 1345 kb/s
```

```
Stream #0:0: Video: h264 (Main), yuv420p(progressive), 854x480 [SAR 1:1 DAR 427:240], 29.97 fps, 29.97 tbr, 1k tbn, 59.94 tbc (default)
```

```
Metadata:
```

```
HANDLER_NAME      : VideoHandler
DURATION          : 00:01:28.054000000
Stream #0:1(eng): Audio: opus, 48000 Hz, stereo, fltp (default)
```

```
Metadata:
```

```
DURATION          : 00:01:28.601000000
```

```
Stream mapping:
```

```
Stream #0:0 -> #0:0 (h264 (native) -> h264 (libx264))
```

```
[libx264 @ 0x55a7225a3600] mb B I16..4: 0.3% 0.5% 0.1% B16..8: 39.3% 7.1% 1.1% direct: 1.4%
skip:50.2% L0:38.7% L1:51.9% BI: 9.5%
[libx264 @ 0x55a7225a3600] 8x8 transform intra:59.5% inter:67.1%
[libx264 @ 0x55a7225a3600] coded y,uvDC,uvAC intra: 39.6% 48.4% 10.8% inter: 15.7% 11.1% 0.1%
[libx264 @ 0x55a7225a3600] i16 v,h,dc,p: 17% 48% 8% 27%
[libx264 @ 0x55a7225a3600] i8 v,h,dc,ddl,ddr,vr,hd,vl,hu: 20% 22% 26% 4% 6% 6% 6% 5% 6%
[libx264 @ 0x55a7225a3600] i4 v,h,dc,ddl,ddr,vr,hd,vl,hu: 21% 22% 16% 5% 9% 8% 9% 5% 6%
[libx264 @ 0x55a7225a3600] i8c dc,h,v,p: 54% 27% 13% 6%
[libx264 @ 0x55a7225a3600] Weighted P-Frames: Y:19.4% UV:4.0%
[libx264 @ 0x55a7225a3600] ref P L0: 65.6% 18.5% 12.9% 2.7% 0.3%
[libx264 @ 0x55a7225a3600] ref B L0: 94.3% 5.0% 0.7%
[libx264 @ 0x55a7225a3600] ref B L1: 98.2% 1.8%
[libx264 @ 0x55a7225a3600] kb/s:2942.84
[aac @ 0x55a72255c800] Qavg: 983.456
wrg@wrg-900X5N:~/study/live_stream$ ls
index.m3u8  segment_000.ts  segment_003.ts  segment_006.ts  star2_zerg.mp4
railgun.mkv  segment_001.ts  segment_004.ts  segment_007.ts
railgun.mp4  segment_002.ts  segment_005.ts  segment_008.ts
wrg@wrg-900X5N:~/study/live_stream$ cat index.m3u8
#EXTM3U
#EXT-X-VERSION:3
#EXT-X-MEDIA-SEQUENCE:0
#EXT-X-ALLOW-CACHE:YES
#EXT-X-TARGETDURATION:17
#EXTINF:16.750067,
segment_000.ts
#EXTINF:8.341667,
segment_001.ts
#EXTINF:8.341667,
segment_002.ts
#EXTINF:8.341667,
segment_003.ts
#EXTINF:8.341667,
segment_004.ts
#EXTINF:16.683333,
segment_005.ts
#EXTINF:8.341667,
segment_006.ts
#EXTINF:8.341667,
segment_007.ts
#EXTINF:4.637967,
segment_008.ts
#EXT-X-ENDLIST
wrg@wrg-900X5N:~/study/live_stream$
```

```
wrg@wrg-900X5N:~/study/live_stream$ ls
index.m3u8  segment_000.ts  segment_003.ts  segment_006.ts  star2_zerg.mp4
railgun.mkv segment_001.ts  segment_004.ts  segment_007.ts
railgun.mp4 segment_002.ts  segment_005.ts  segment_008.ts
wrg@wrg-900X5N:~/study/live_stream$ ffplay segment_008.ts
ffplay version 4.1.1-0york1~16.04 Copyright (c) 2003-2019 the FFmpeg developers
built with gcc 5.4.0 (Ubuntu 5.4.0-6ubuntu1~16.04.11) 20160609
configuration: --prefix=/usr --extra-version '0york1~16.04' --toolchain=hardened --libdir=/usr/lib
```

```
b/x86_64-linux-gnu --incdir=
ping --enable-avresample --d
a --enable-libaom --enable-l
cdio --enable-libcodec2 --en
ribidi --enable-libgme --ena
able-libopenjpeg --enable-li
ibrubberband --enable-libshi
h --enable-libtheora --enabl
nable-libwavpack --enable-li
q --enable-libzvbi --enable-
-nonfree --enable-libfdk-aac
aprint --enable-frei0r --ena
libavutil 56. 22.100
libavcodec 58. 35.100
libavformat 58. 20.100
libavdevice 58. 5.100
libavfilter 7. 40.101
libavresample 4. 0. 0
libswscale 5. 3.100
libswresample 3. 3.100
libpostproc 55. 3.100
Input #0, mpegts, from 'segm
Duration: 00:00:04.68, sta
Program 1
Metadata:
service_name : Serv
service_provider: FFmp
Stream #0:0[0x100]: Vide
[SAR 1281:1280 DAR 427:240]
Stream #0:1[0x101](eng):
/s
87.15 A-V: -0.011 fd= 0
```





```
wrg@wrg-900X5N:~/study/live_stream$ ls
index.m3u8  segment_000.ts  segment_003.ts  segment_006.ts  star2_zerg.mp4
railgun.mkv segment_001.ts  segment_004.ts  segment_007.ts
railgun.mp4 segment_002.ts  segment_005.ts  segment_008.ts
wrg@wrg-900X5N:~/study/live_stream$ rm -rf index.m3u8
wrg@wrg-900X5N:~/study/live_stream$ rm -rf *.ts
wrg@wrg-900X5N:~/study/live_stream$ ls
railgun.mkv railgun.mp4 star2_zerg.mp4
wrg@wrg-900X5N:~/study/live_stream$ cp ../create-vod-hls.sh ./
wrg@wrg-900X5N:~/study/live_stream$ ls
create-vod-hls.sh railgun.mkv railgun.mp4 star2_zerg.mp4
wrg@wrg-900X5N:~/study/live_stream$ █
```

```
#!/usr/bin/env bash

set -e

# Usage create-vod-hls.sh SOURCE_FILE [OUTPUT_NAME]
[[ ! "${1}" ]] && echo "Usage: create-vod-hls.sh SOURCE_FILE [OUTPUT_NAME]" && exit 1

# comment/add lines here to control which renditions would be created
renditions=(
# resolution  bitrate  audio-rate
# "426x240    400k    64k"
  "640x360    800k    96k"
  "842x480    1400k   128k"
  "1280x720   2800k   128k"
  "1920x1080  5000k   192k"
)

segment_target_duration=4      # try to create a new segment every X seconds
max_bitrate_ratio=1.07        # maximum accepted bitrate fluctuations
rate_monitor_buffer_ratio=1.5 # maximum buffer size between bitrate conformance checks
```

```
#####
```

```
source="${1}"
target="${2}"
if [[ ! "${target}" ]]; then
    target="${source##*/}" # leave only last component of path
    target="${target%.*}" # strip extension
fi
mkdir -p ${target}
```

```
key_frames_interval="$(echo `ffprobe ${source} 2>&1 | grep -oE '[[[:digit:]]+(\.[[:digit:]]+)? fps' |
    grep -oE '[[[:digit:]]+(\.[[:digit:]]+)?`*2 | bc || echo '')"
key_frames_interval=${key_frames_interval:-50}
key_frames_interval=$(echo `printf "%.1f\n" $(bc -l <<<"$key_frames_interval/10")`*10 | bc) # round
key_frames_interval=${key_frames_interval%.*} # truncate to integer
```

```
# static parameters that are similar for all renditions
static_params="-c:a aac -ar 48000 -c:v h264 -profile:v main -crf 20 -sc_threshold 0"
static_params+=" -g ${key_frames_interval} -keyint_min ${key_frames_interval} -hls_time ${segment_t
arget_duration}"
static_params+=" -hls_playlist_type vod"
```

```
# misc params
misc_params="-hide_banner -y"
```

```
master_playlist="#EXTM3U
#EXT-X-VERSION:3
"
```



```

cmd=""
for rendition in "${renditions[@]"; do
    # drop extraneous spaces
    rendition="${rendition/[:space:]]+/ }"

    # rendition fields
    resolution="$(echo ${rendition} | cut -d ' ' -f 1)"
    bitrate="$(echo ${rendition} | cut -d ' ' -f 2)"
    audiorate="$(echo ${rendition} | cut -d ' ' -f 3)"

    # calculated fields
    width="$(echo ${resolution} | grep -oE '^[[[:digit:]]+')"
    height="$(echo ${resolution} | grep -oE '[[[:digit:]]+$')"
    maxrate="$(echo "`echo ${bitrate} | grep -oE '[[[:digit:]]+'`*${max_bitrate_ratio}" | bc)"
    bufsize="$(echo "`echo ${bitrate} | grep -oE '[[[:digit:]]+'`*${rate_monitor_buffer_ratio}" | bc)"
    bandwidth="$(echo ${bitrate} | grep -oE '[[[:digit:]]+'')000"
    name="${height}p"

    cmd+=" ${static_params} -vf scale=w=${width}:h=${height}:force_original_aspect_ratio=decrease"
    cmd+=" -b:v ${bitrate} -maxrate ${maxrate%.*}k -bufsize ${bufsize%.*}k -b:a ${audiorate}"
    cmd+=" -hls_segment_filename ${target}/${name}_%03d.ts ${target}/${name}.m3u8"

    # add rendition entry in the master playlist
    master_playlist+=" #EXT-X-STREAM-INF:BANDWIDTH=${bandwidth},RESOLUTION=${resolution}\n${name}.m3u8\n"
done

# start conversion
echo -e "Executing command:\nffmpeg ${misc_params} -i ${source} ${cmd}"
ffmpeg ${misc_params} -i ${source} ${cmd}

# create master playlist file
echo -e "${master_playlist}" > ${target}/playlist.m3u8

echo "Done - encoded HLS is at ${target}/"

```

```
wrg@wrg-900X5N:~/study/live_stream$ sudo apt-get install v4l-utils
[sudo] password for wrg:
Reading package lists... Done
Building dependency tree
Reading state information... Done
v4l-utils is already the newest version (1.10.0-1).
The following packages were automatically installed and are no longer required:
  linux-headers-4.15.0-29 linux-headers-4.15.0-29-generic linux-headers-4.15.0-38
  linux-headers-4.15.0-38-generic linux-headers-4.15.0-39 linux-headers-4.15.0-39-generic
  linux-headers-4.15.0-42 linux-headers-4.15.0-42-generic linux-image-4.15.0-29-generic
  linux-image-4.15.0-38-generic linux-image-4.15.0-39-generic linux-image-4.15.0-42-generic
  linux-modules-4.15.0-29-generic linux-modules-4.15.0-38-generic linux-modules-4.15.0-39-generic
  linux-modules-4.15.0-42-generic linux-modules-extra-4.15.0-29-generic
  linux-modules-extra-4.15.0-38-generic linux-modules-extra-4.15.0-39-generic
  linux-modules-extra-4.15.0-42-generic
Use 'sudo apt autoremove' to remove them.
0 upgraded, 0 newly installed, 0 to remove and 81 not upgraded.
wrg@wrg-900X5N:~/study/live_stream$ █
```

```
wrg@wrg-900X5N:~/study/live_stream$ v4l2-ctl
```

#### General/Common options:

```
--all          display all information available
-C, --get-ctrl=<ctrl>[,<ctrl>...]
               get the value of the controls [VIDIOC_G_EXT_CTRL]
-c, --set-ctrl=<ctrl>=<val>[,<ctrl>=<val>...]
               set the value of the controls [VIDIOC_S_EXT_CTRL]
-D, --info      show driver info [VIDIOC_QUERYCAP]
-d, --device=<dev> use device <dev> instead of /dev/video0
               if <dev> starts with a digit, then /dev/video<dev> is used
-e, --out-device=<dev> use device <dev> for output streams instead of the
               default device as set with --device
               if <dev> starts with a digit, then /dev/video<dev> is used
-h, --help      display this help message
--help-all     all options
--help-io       input/output options
--help-misc     miscellaneous options
--help-overlay  overlay format options
--help-sdr      SDR format options
--help-selection crop/selection options
--help-stds     standards and other video timings options
--help-streaming streaming options
--help-tuner    tuner/modulator options
--help-vbi      VBI format options
--help-vidcap   video capture format options
--help-vidout   vidout output format options
--help-edid     edid handling options
-k, --concise   be more concise if possible.
-l, --list-ctrls display all controls and their values [VIDIOC_QUERYCTRL]
-L, --list-ctrls-menus
               display all controls and their menus [VIDIOC_QUERYMENU]
-r, --subset=<ctrl>[,<offset>,<size>]+
               the subset of the N-dimensional array to get/set for control <ctrl>,
               for every dimension an (<offset>, <size>) tuple is given.
-w, --wrapper   use the libv4l2 wrapper library.
--list-devices  list all v4l devices
--log-status    log the board status in the kernel log [VIDIOC_LOG_STATUS]
--get-priority  query the current access priority [VIDIOC_G_PRIORITY]
--set-priority=<prio>
               set the new access priority [VIDIOC_S_PRIORITY]
               <prio> is 1 (background), 2 (interactive) or 3 (record)
--silent        only set the result code, do not print any messages
--sleep=<secs>  sleep <secs>, call QUERYCAP and close the file handle
--verbose       turn on verbose ioctl status reporting
```

```
wrg@wrg-900X5N:~/study/live_stream$
```

```

wrg@wrg-900X5N:~/study/live_stream$ ffmpeg -f v4l2 -i /dev/video0 notebook_cam.mp4
ffmpeg version 4.1.1-0york1~16.04 Copyright (c) 2000-2019 the FFmpeg developers
  built with gcc 5.4.0 (Ubuntu 5.4.0-6ubuntu1~16.04.11) 20160609
  configuration: --prefix=/usr --extra-version='0york1~16.04' --toolchain=hardened --libdir=/usr/li
b/x86_64-linux-gnu --incdir=/usr/include/x86_64-linux-gnu --arch=amd64 --enable-gpl --disable-strip
ping --enable-avresample --disable-filter=resample --enable-avisynth --enable-gnutls --enable-ladsp
a --enable-libaom --enable-libass --enable-libbluray --enable-libbs2b --enable-libcaca --enable-lib
cdio --enable-libcodec2 --enable-libflite --enable-libfontconfig --enable-libfreetype --enable-libf
ribidi --enable-libgme --enable-libgsm --enable-libjack --enable-libmp3lame --enable-libmysofa --en
able-libopenjpeg --enable-libopenmpt --enable-libopus --enable-libpulse --enable-librsvg --enable-l
ibrubberband --enable-libshine --enable-lbsnappy --enable-libsoxr --enable-lbspeex --enable-libss
h --enable-libtheora --enable-libtwolame --enable-libvidstab --enable-libvorbis --enable-libvpx --e
nable-libwavpack --enable-libwebp --enable-libx265 --enable-libxml2 --enable-libxvid --enable-libzm
q --enable-libzvbi --enable-lv2 --enable-omx --enable-opengl --enable-sdl2 --enable
-nonfree --enable-libfdk-aac --enable-libdc1394 --enable-libdrm --enable-libiec61883 --enable-chrom
aprint --enable-frei0r --enable-libx264 --enable-shared
  libavutil      56. 22.100 / 56. 22.100
  libavcodec     58. 35.100 / 58. 35.100
  libavformat    58. 20.100 / 58. 20.100
  libavdevice    58.  5.100 / 58.  5.100
  libavfilter     7. 40.101 /  7. 40.101
  libavresample   4.  0.  0 /  4.  0.  0
  libswscale     5.  3.100 /  5.  3.100
  libswresample   3.  3.100 /  3.  3.100
  libpostproc    55.  3.100 / 55.  3.100
Input #0, video4linux2,v4l2, from '/dev/video0':
  Duration: N/A, start: 15837.661850, bitrate: 147456 kb/s
    Stream #0:0: Video: rawvideo (YUY2 / 0x32595559), yuyv422, 640x480, 147456 kb/s, 30 fps, 30 tbr
    , 1000k tbn, 1000k tbc
Stream mapping:
  Stream #0:0 -> #0:0 (rawvideo (native) -> h264 (libx264))
Press [q] to stop, [?] for help
[libx264 @ 0x55cc65a65240] using cpu capabilities: MMX2 SSE2Fast SSSE3 SSE4.2 AVX FMA3 BMI2 AVX2
[libx264 @ 0x55cc65a65240] profile High 4:2:2, level 3.0, 4:2:2 8-bit
[libx264 @ 0x55cc65a65240] 264 - core 155 r2917 0a84d98 - H.264/MPEG-4 AVC codec - Copyleft 2003-20
18 - http://www.videolan.org/x264.html - options: cabac=1 ref=3 deblock=1:0:0 analyse=0x3:0x113 me=
hex subme=7 psy=1 psy_rd=1.00:0.00 mixed_ref=1 me_range=16 chroma_me=1 trellis=1 8x8dct=1 cqm=0 dea
dzone=21,11 fast_pskip=1 chroma_qp_offset=-2 threads=6 lookahead_threads=1 sliced_threads=0 nr=0 de
cimate=1 interlaced=0 bluray_compat=0 constrained_intra=0 bframes=3 b_pyramid=2 b_adapt=1 b_bias=0
direct=1 weightb=1 open_gop=0 weightp=2 keyint=250 keyint_min=25 scenecut=40 intra_refresh=0 rc_loo
kahead=40 rc=crf mbtree=1 crf=23.0 qcomp=0.60 qpmin=0 qpmax=69 qpstep=4 ip_ratio=1.40 aq=1:1.00
Output #0, mp4, to 'notebook_cam.mp4':
  Metadata:
    encoder      : Lavf58.20.100
    Stream #0:0: Video: h264 (libx264) (avc1 / 0x31637661), yuv422p, 640x480, q=-1--1, 30 fps, 1536
    0 tbn, 30 tbc

```

```

libavfilter      7. 40.101 / 7. 40.101
libavresample    4.  0.  0 / 4.  0.  0
libswscale       5.  3.100 / 5.  3.100
libswresample    3.  3.100 / 3.  3.100
libpostproc     55.  3.100 / 55.  3.100
Input #0, video4linux2,v4l2, from '/dev/video0':
  Duration: N/A, start: 15837.661850, bitrate: 147456 kb/s
    Stream #0:0: Video: rawvideo (YUY2 / 0x32595559), yuyv422, 640x480, 147456 kb/s, 30 fps, 30 tbr
    , 1000k tbn, 1000k tbc
Stream mapping:
  Stream #0:0 -> #0:0 (rawvideo (native) -> h264 (libx264))
Press [q] to stop, [?] for help
[libx264 @ 0x55cc65a65240] using cpu capabilities: MMX2 SSE2Fast SSSE3 SSE4.2 AVX FMA3 BMI2 AVX2
[libx264 @ 0x55cc65a65240] profile High 4:2:2, level 3.0, 4:2:2 8-bit
[libx264 @ 0x55cc65a65240] 264 - core 155 r2917 0a84d98 - H.264/MPEG-4 AVC codec - Copyleft 2003-20
18 - http://www.videolan.org/x264.html - options: cabac=1 ref=3 deblock=1:0:0 analyse=0x3:0x113 me=
hex subme=7 psy=1 psy_rd=1.00:0.00 mixed_ref=1 me_range=16 chroma_me=1 trellis=1 8x8dct=1 cqm=0 dea
dzone=21,11 fast_pskip=1 chroma_qp_offset=-2 threads=6 lookahead_threads=1 sliced_threads=0 nr=0 de
cimate=1 interlaced=0 bluray_compat=0 constrained_intra=0 bframes=3 b_pyramid=2 b_adapt=1 b_bias=0
direct=1 weightb=1 open_gop=0 weightp=2 keyint=250 keyint_min=25 scenecut=40 intra_refresh=0 rc_loo
kahead=40 rc=crf mbtree=1 crf=23.0 qcomp=0.60 qpmin=0 qpmax=69 qpstep=4 ip_ratio=1.40 aq=1:1.00
Output #0, mp4, to 'notebook_cam.mp4':
  Metadata:
    encoder      : Lavf58.20.100
    Stream #0:0: Video: h264 (libx264) (avc1 / 0x31637661), yuv422p, 640x480, q=-1--1, 30 fps, 1536
0 tbn, 30 tbc
    Metadata:
      encoder      : Lavc58.35.100 libx264
    Side data:
      cpb: bitrate max/min/avg: 0/0/0 buffer size: 0 vbv_delay: -1
frame= 63 fps= 31 q=29.0 size=      0kB time=00:00:00.33 bitrate=   1.2kbits/s dup=2 drop=0 spee
frame= 78 fps= 31 q=29.0 size=      0kB time=00:00:00.83 bitrate=   0.5kbits/s dup=2 drop=0 spee
frame= 92 fps= 30 q=29.0 size=      0kB time=00:00:01.30 bitrate=   0.3kbits/s dup=2 drop=0 spee
frame= 107 fps= 30 q=29.0 size=    256kB time=00:00:01.80 bitrate=1165.3kbits/s dup=2 drop=0 spee
frame= 122 fps= 30 q=29.0 size=    256kB time=00:00:02.30 bitrate= 911.9kbits/s dup=2 drop=0 spee
frame= 137 fps= 30 q=29.0 size=    256kB time=00:00:02.80 bitrate= 749.1kbits/s dup=2 drop=0 spee
frame= 152 fps= 30 q=29.0 size=    512kB time=00:00:03.30 bitrate=1271.1kbits/s dup=2 drop=0 spee
frame= 168 fps= 30 q=29.0 size=    512kB time=00:00:03.83 bitrate=1094.2kbits/s dup=3 drop=0 spee
frame= 183 fps= 30 q=29.0 size=    512kB time=00:00:04.33 bitrate= 968.0kbits/s dup=3 drop=0 spee
frame= 198 fps= 30 q=29.0 size=    512kB time=00:00:04.83 bitrate= 867.9kbits/s dup=3 drop=0 spee
frame= 213 fps= 30 q=29.0 size=    768kB time=00:00:05.33 bitrate=1179.7kbits/s dup=3 drop=0 spee
frame= 227 fps= 30 q=29.0 size=    768kB time=00:00:05.80 bitrate=1084.8kbits/s dup=3 drop=0 spee
frame= 242 fps= 30 q=29.0 size=    768kB time=00:00:06.30 bitrate= 998.7kbits/s dup=11 drop=0 spe
frame= 258 fps= 30 q=29.0 size=   1024kB time=00:00:06.83 bitrate=1227.6kbits/s dup=19 drop=0 spe
frame= 273 fps= 30 q=29.0 size=   1024kB time=00:00:07.33 bitrate=1143.9kbits/s dup=27 drop=0 spe
ed=0.811x

```



```
wrg@wrg-900X5N:~/study/live_stream$ ls
create-vod-hls.sh  notebook_cam.mp4  railgun.mkv  railgun.mp4  star2_zerg.mp4
wrg@wrg-900X5N:~/study/live_stream$ ffplay notebook_cam.mp4
```

```
ffplay version 4.1.1-0york1-
built with gcc 5.4.0 (Ubuntu
configuration: --prefix=/u
b/x86_64-linux-gnu --incdir=
ping --enable-avresample --d
a --enable-libaom --enable-l
cdio --enable-libcodec2 --en
ribidi --enable-libgme --ena
able-libopenjpeg --enable-li
ibrubberband --enable-libshi
h --enable-libtheora --enabl
nable-libwavpack --enable-li
q --enable-libzvbi --enable-
-nonfree --enable-libfdk-aac
aprint --enable-frei0r --ena
libavutil      56. 22.100
libavcodec      58. 35.100
libavformat     58. 20.100
libavdevice     58.  5.100
libavfilter     7. 40.101
libavresample   4.  0.  0
libswscale      5.  3.100
libswresample   3.  3.100
libpostproc    55.  3.100
Input #0, mov,mp4,m4a,3gp,3g
Metadata:
  major_brand      : isom
  minor_version    : 512
  compatible_brands: isom
  encoder          : Lavf58
Duration: 00:00:20.57, start: 0.000000, bitrate: 1061 kb/s
  Stream #0:0(und): Video: h264 (High 4:2:2) (avc1 / 0x31637661), yuv422p, 640x480, 1058 kb/s, 30
fps, 30 tbr, 15360 tbn, 60 tbc (default)
Metadata:
  handler_name     : VideoHandler
7.32 M-V: 0.000 fd= 0 aq= 0KB vq= 92KB sq= 0B f=0/0
```

