

LiveVideoStackCon

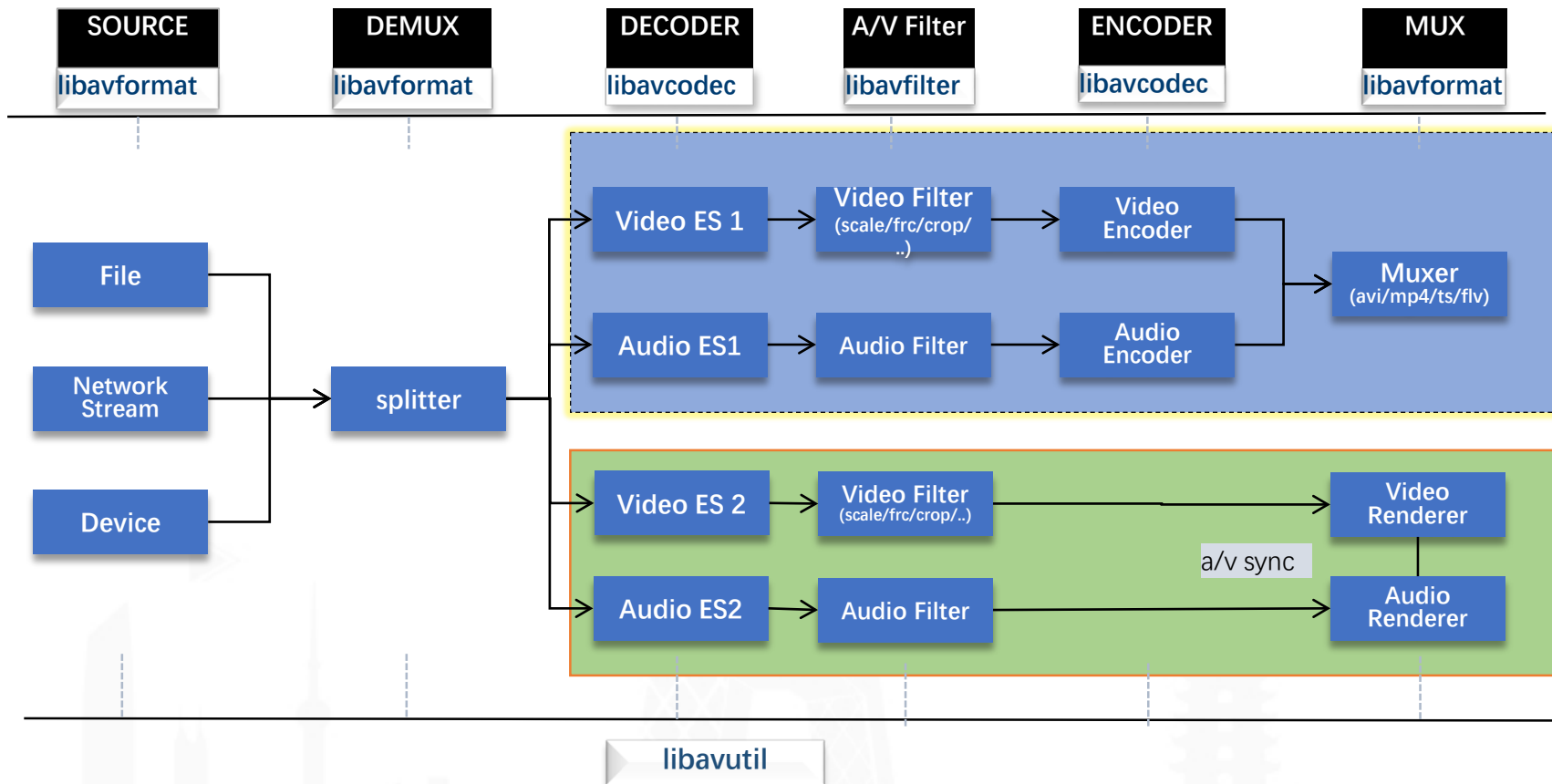
FFmpeg在Intel GPU上的 硬件加速与优化

赵军

DCG/NPG @ Intel

- Media pipeline review
- 何谓FFmpeg VAAPI
- 为什么我们需要FFmpeg VAAPI
- 当前状态
- 更进一步的计划
- 附录

典型的 media pipeline





- **FFmpeg**

- The most popular open-source multimedia manipulation tools with a library of plugins that can be applied to various parts of the audio and video processing pipelines and have achieved wide adoption across the world. (<https://developer.nvidia.com/ffmpeg>)

- **Tools and Library**

- To Convert, manipulate and stream multimedia formats and protocols
- Written in C/ASM, Open Source
- Multiplatform: GNU/Linux, Mac OSX, Android, MS Windows, ...

- **License: GNU GPLv2 or GNU LGPLv2.1.**

- Refer to <https://ffmpeg.org/legal.html>



- **Xv (X video extension)**
 - Scaling
 - Color space conversion(YUV to RGB)
- **XvMC (X-video Motion Compensation)**
 - MPEG-2 decoding
 - Motion compensation, *iDCT*.
 - XvMC-VLD
 - *VLD* (slice level acceleration)
 - MPEG-2, MPEG-4 on VIA Unichrome
- **Xv/XvMC 的限制**
 - 不支持解码所有阶段的硬件加速
 - 依赖于X-protocol协议 (转码时候, 你需要Xwindow吗?)
 - 不支持硬件编码加速
 - ...



- **何谓VA-API(Video Acceleration API)**
 - An API specification
 - Client side
 - Driver (backend) side
 - A library implementation
 - Open Source MIT license
 - It opens and registers a backend
- <https://github.com/01org/libva>
- **依赖于后端驱动，可以提供Video硬件加速**
 - 解码
 - 编码
 - 图像后处理



- [Intel VA\(i965\) driver](#) for Intel chip-sets
- [Intel hybrid driver](#)
- Intel HD driver
- [Mesa's state-trackers](#) for gallium drivers:
 - radeon, nouveau (?), freedreno, ...
- 废弃的 API bridges
 - [vdpau—va](#) bridge
 - [powervr—va](#) bridge
 - ...



- **Gfx Label**

- Gen3: Pinetrail (Pineview)
- Gen4: G965
- Gen5: G4X, Ironlake (Piketon, Calpella)
- Gen6: Sandy Bridge
- Gen7: Ivy Bridge, Bay Trail
- Gen7.5: Haswell
- Gen8: Broadwell, Braswell (CherryView)
- Gen9: Skylake, Broxton-P
- Gen 9.5: Kabylake
- ...

- **Intel® Processor Graphics**

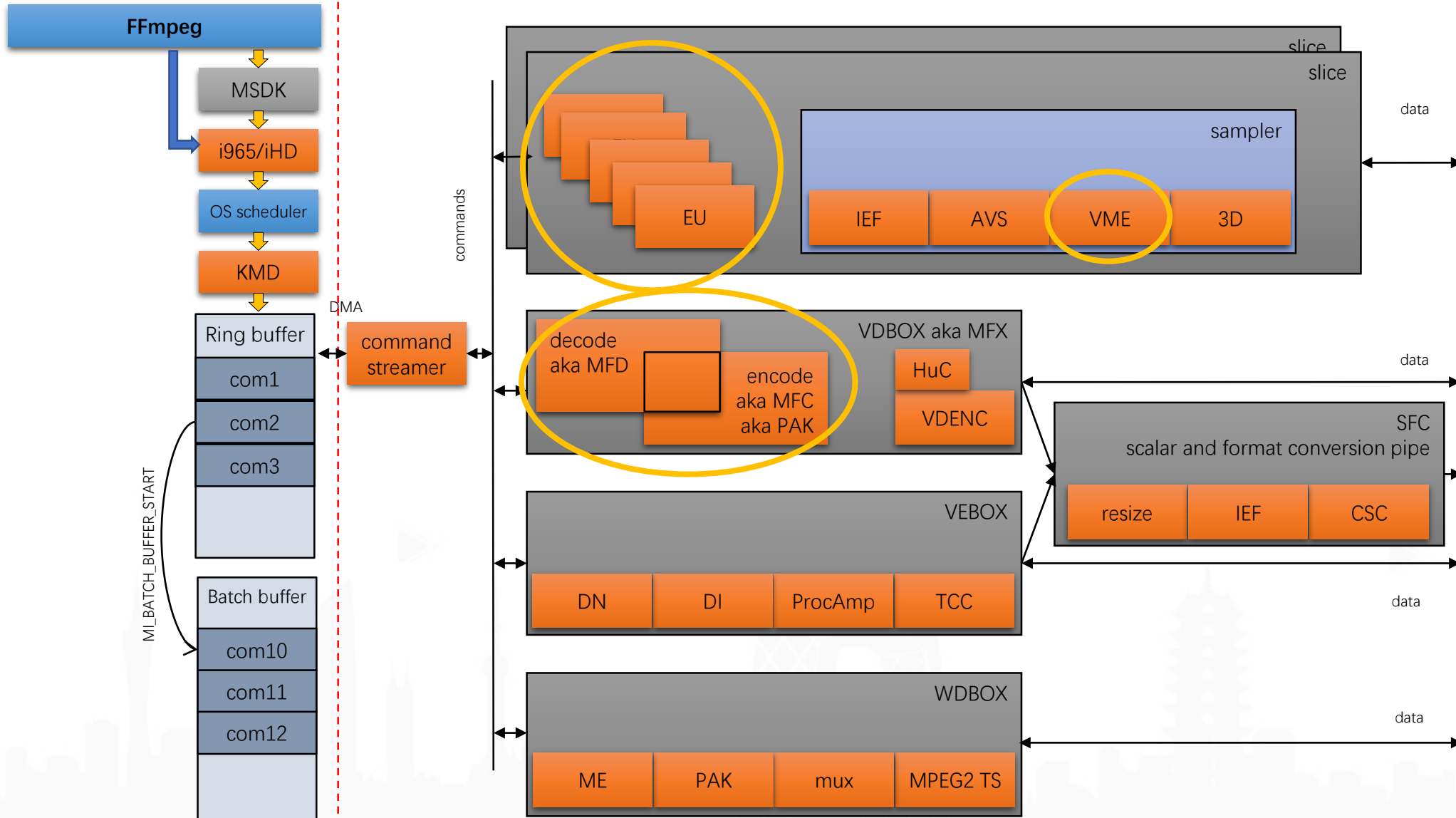
- 3D 渲染(OpenGL & Vulkan)
- Media
- 显示与计算 (CUDA & OpenCL)



Intel GPU media 硬件编程模型

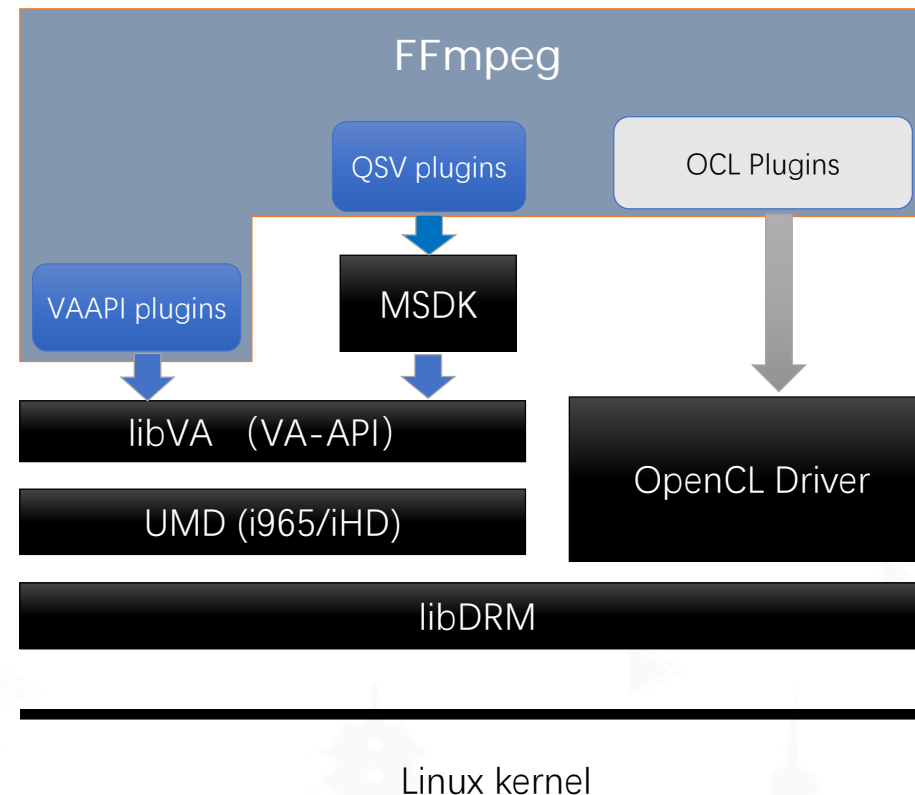
CPU

GPU



FFmpeg & Intel GPU加速方案

- **FFmpeg** 作为最流行的开源多媒体框架; 集成Intel的GPU的硬件加速能为用户带来更多收益
- **FFmpeg QSV plugins** 基于MSS/Media SDK, 这类似于FFmpeg 集成Libx264的方式
- **VA-API** 作为一个底层的Media硬件加速API; **FFmpeg VA-API** 提供更灵活, 更开放的方案
- 可以集成**OpenCL/OpenCV video processing Library** 以适应更多的用户需求





Intel GPU Encoder 的支持

Platform	8-bit					10-bit	
	H.264 / AVC	H.265 / HEVC	MJPEG	VP8	VP9	H.265 / HEVC	VP9
Sandy Bridge	✓	-	-	-	-	-	-
Ivy Bridge	✓	-	-	-	-	-	-
Bay Trail	✓	-	-	-	-	-	-
Haswell	✓	-	-	-	-	-	-
Broadwell	✓	-	-	✓	-	-	-
Cherry Trail / Braswell	✓	-	-	✓	-	-	-
Skylake	✓	✓	✓	✓	-	-	-
Apollo Lake	✓	✓	✓	✓	-	-	-
Kaby Lake	✓	✓	✓	✓	✓	✓	-



• 解码

- `ffmpeg -hwaccel vaapi -hwaccel_device /dev/dri/renderD128 -i input.mp4 -c:v libx264 -crf 20 output.mp4`

• 编码

- `ffmpeg -vaapi_device /dev/dri/renderD128 -i input.mp4 -vf 'format=p010,hwupload' -c:v hevc_vaapi -b:v 15M -profile 2 output.mp4`

• 转码

- `ffmpeg -hwaccel vaapi -hwaccel_device /dev/dri/renderD128 -hwaccel_output_format vaapi -i input.mp4 -vf 'deinterlace_vaapi=rate=field:auto=1,scale_vaapi=w=1280:h=720' -c:v hevc_vaapi -b:v 5M output.mp4`



FFmpeg 硬件加速全览

	Decoder			Encoder		Other support		
	Internal (AVHWaccel)	Standalone	Hardware output	Standalone	Hardware input	Filtering	Hardware context	Usable from ffmpeg CLI
CUDA / CUVID / NVENC	N	Y	Y	Y	Y	Y	Y	Y
Direct3D 11	Y	-	Y	-	-	F	Y	Y
Direct3D 9 / DXVA2	Y	-	Y	-	-	N	Y	Y
libmfx	-	Y	Y	Y	Y	Y	Y	Y
MediaCodec	-	Y	Y	N	N	-	N	N
Media Foundation	-	N	N	N	N	N	N	N
MMAL	-	Y	Y	N	N	-	N	N
OpenCL	-	-	-	-	-	Y	F	F
OpenMAX	-	N	N	Y	N	N	N	Y
RockChip MPP	-	Y	Y	N	N	-	Y	Y
V4L2 M2M	-	Y	N	Y	N	N	N	Y
VAAPI	Y	-	Y	Y	Y	Y	Y	Y
VDA	Y	N	Y	-	-	-	N	Y
VDPAU	Y	-	Y	-	-	N	Y	Y
VideoToolbox	Y	N	Y	Y	Y	-	Y	Y

- Key:
- Not applicable to this API.
 - Y Working.
 - N Possible but not implemented.
 - F Not yet integrated, but work is being done in this area.



- HWAccel Decoder与Native Decoder
- Encoder
 - 速度与单路的功耗比
 - 有了速度，图像质量怎么样
 - FEI
- AVFilter (VPP)
 - Scaling
 - De-interlace
 - The others
 - 如果硬件或者驱动不支持，该怎么办？



- **CPU 与 GPU的数据交换**
 - 为什么我们关注这个问题?
 - 数据从 CPU到GPU与数据从GPU到CPU并不对等
 - Mmap
 - SSE4/AVX/...
 - GPU Copy
 - OpenCL SVM
- **FFmpeg 里面的Hwupload/Hwdownload/Hwmap/Hwunmap**
- **如果硬件或者驱动不支持，可以怎么办**
 - OpenCL来解救



FFmpeg VAAPI

- 已经在各种Linux 分发版本中支持
- 支持的硬件更加广泛
- 更多的Codec的支持
- VAAPI 作为一个Linux上的Video 硬件加速接口，同时也可以支持AMD / Nvidia hardware with Mesa.
- 与其他标准APIs集成较好 (EGL/OpenGL, OpenCL).

FFmpeg QSV

- 某些Cases下图像质量更好
- 可能支持的转码路数更多一些 (particularly on Iris graphics)
- 同时可以支持Windows平台
- 可以与Intel OpenCL 交互

- **图像质量**
 - Flexible Encoding Interface(FEI)
- **更多的Features (WIP)**
 - Less than more.
- **OpenCL optimize the FFmpeg VAAPI (WIP)**
 - 当Intel GPU的VPP不支持或Driver (i965/iHD) 不支持某些特性, 该怎么办?
 - 使用OpenCL 去Fill the gap
 - Zero-Copy, 支持Surface 与 OpenCL之间的Buffer Sharing,避免CPU/GPU之间的数据交换
- **OpenCV for FFmpeg (ToDo)**
 - OpenCV 已经支持OpenCL的优化, 使用T-API (<http://opencv.org/platforms/opengl.html>)
 - 充分利用OpenCL优化过的OpenCV
 - 重新发明轮子? 不是每个客户都有时间或能力重新实现图像算法



Use The Source, Luke!





- **FFmpeg 社区**

- Mark Thompson & wm4

- **Intel**

- DCG/NPG Media Team

- Yi Wang & Kaixuan Liu & Yi Liu & Jing Li & Zhengxu Huang & Andrew & James & Cheng Zhou

- SSG/OTC Media Team

- Haihao Xiang & Zhong Li & Pengfei Qu & Guangxin Xu & Jocelyn

- CCG/CHD NAS Team

- Gohad, Tushar & Quintanar, Sergio

Thank You

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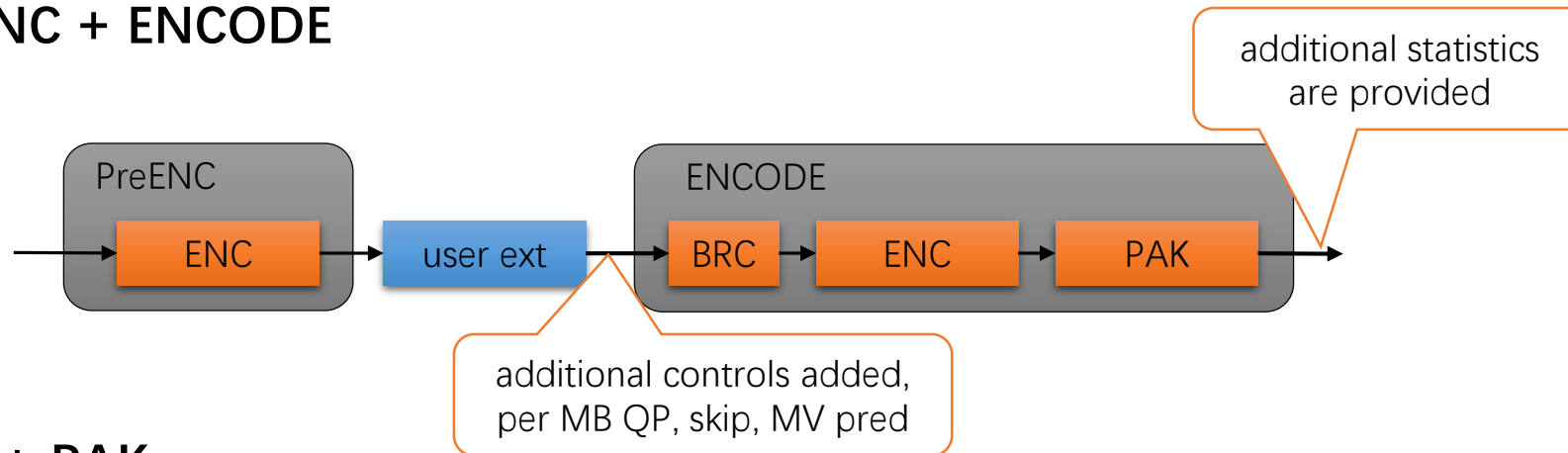


- 4类FEI调用接口：PreENC / ENCODE / ENC / PAK.
- 2种使用模型:
 - PreENC + ENCODE
 - ENC followed by PAK

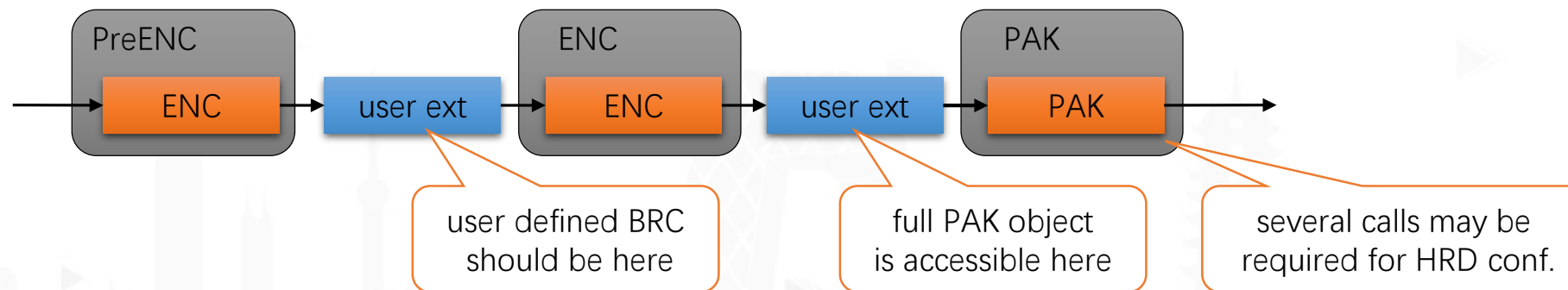
	Pros	Cons
PreENC + ENCODE	<ul style="list-style-type: none">• good set of controls• easy to use	<ul style="list-style-type: none">• limited control over PAK step
ENC followed by PAK	<ul style="list-style-type: none">• ultimate control of encoding process	<ul style="list-style-type: none">• hard to use• lost of performance due to break of HW pipeline



PreENC + ENCODE



ENC + PAK





- **编译安装i965 driver和Libva**

- 可以参考 <https://github.com/01org/libyami/wiki/Build>
- intel-vaapi-driver <https://github.com/01org/intel-vaapi-driver>
- Libva <https://github.com/01org/libva>

- **FFmpeg**

- <https://git.ffmpeg.org/ffmpeg.git>
- 在vainfo 运行成功后, ./configure --enable-vaapi 去enable VA-API, 编译完成之后通过./ffmpeg -encoders | grep vaapi检测编译是否成功



- **FFmpeg 的硬件加速综述**

- <https://trac.ffmpeg.org/wiki/HWAccelIntro>

- **FFmpeg VAAPI的使用**

- <https://trac.ffmpeg.org/wiki/Hardware/VAAPI>
- <https://wiki.libav.org/Hardware/vaapi>

- **Buffer Sharing**

- https://www.khronos.org/registry/OpenCL/extensions/intel/cl_intel_va_api_media_sharing.txt
- <https://www.freedesktop.org/wiki/Software/Beignet/howto/libva-buffer-sharing-howto/>

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