The Lima Driver: Liberating the ARM Mali GPU

Luc Verhaegen

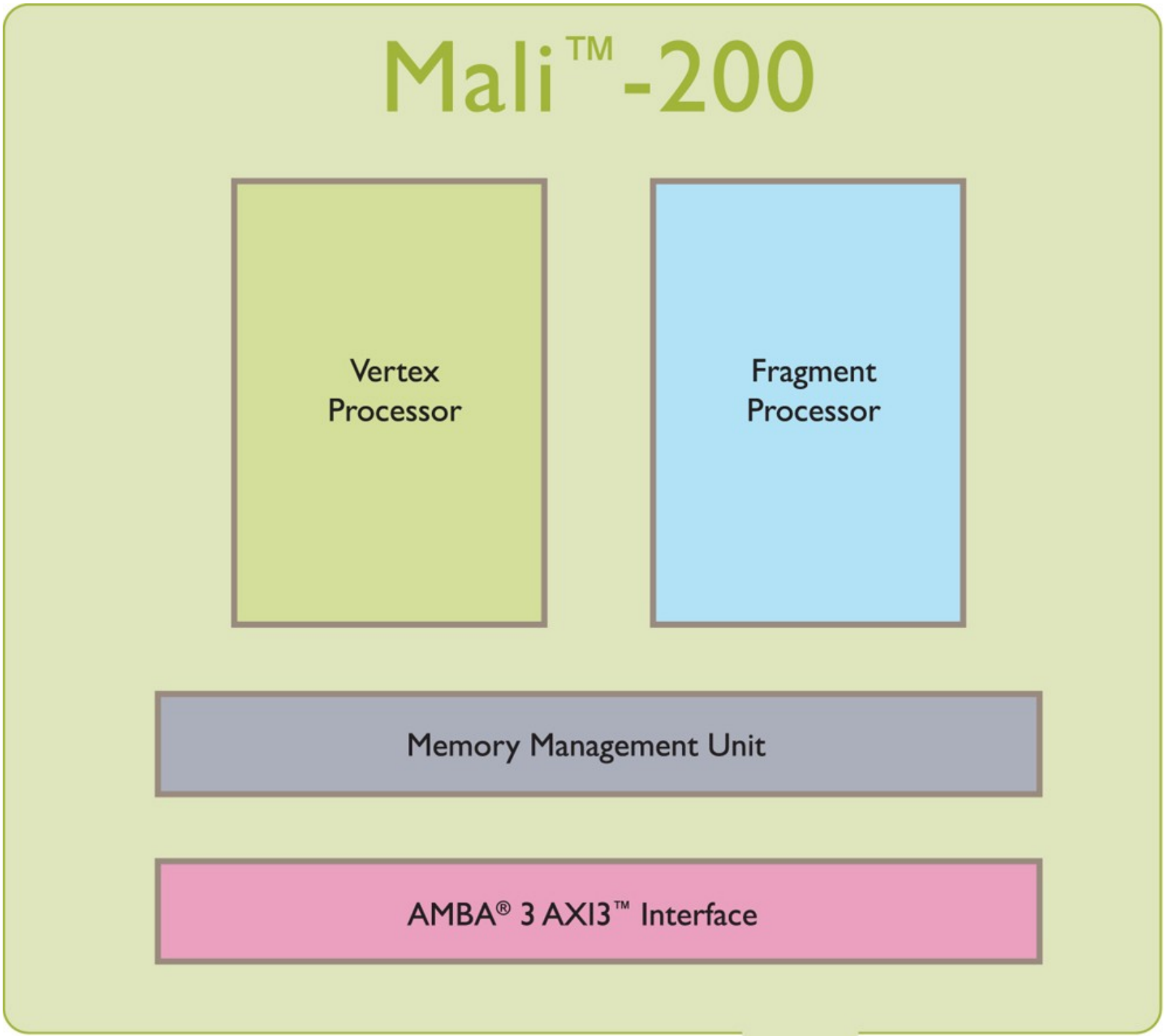
libv@codethink.co.uk

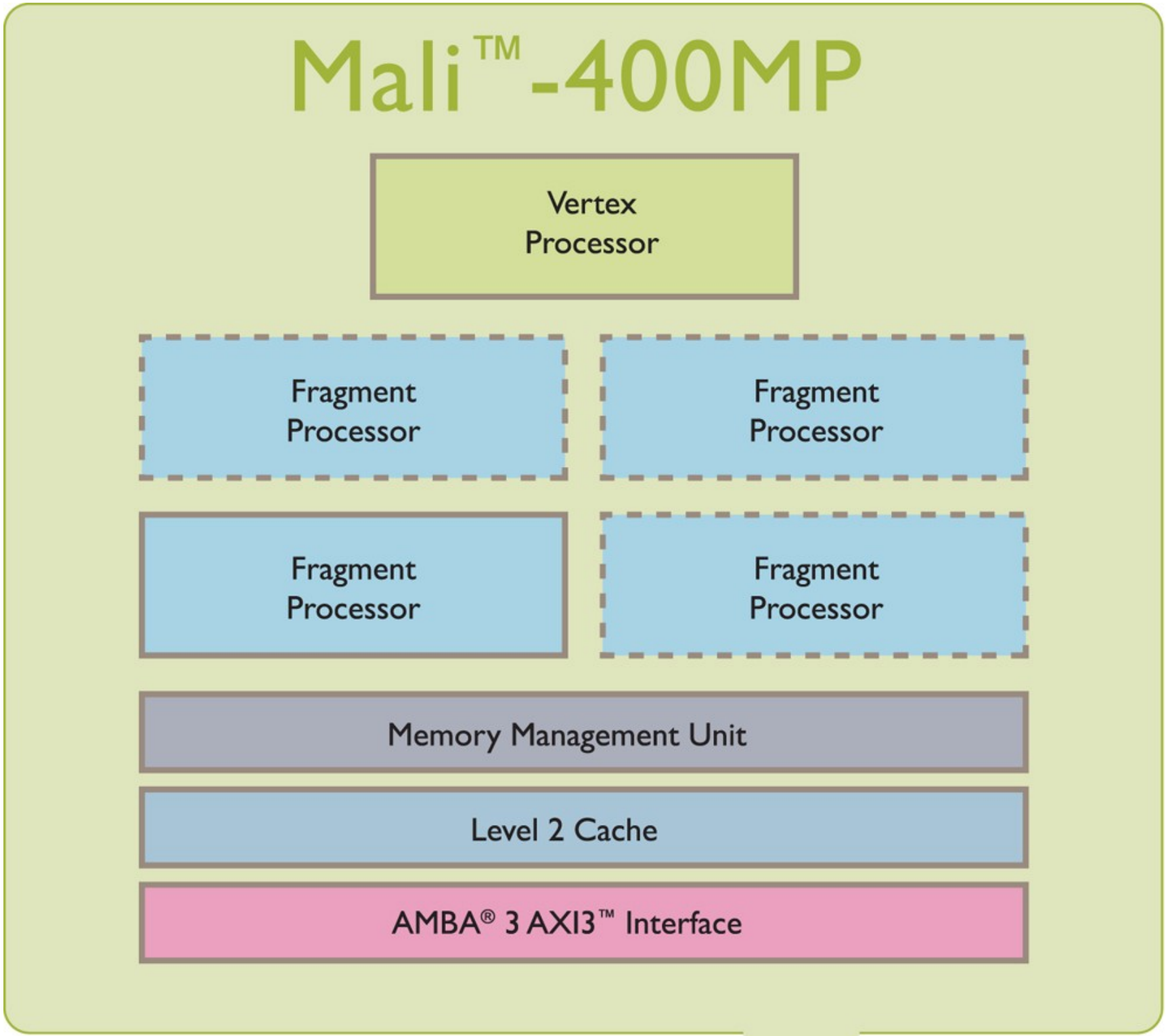
Why?

- x86 vs ARM
- GNU/Linux vs Android/Linux
- Manufacturers vs Users

ARM GPU Vendors

- Imagination
- Qualcomm
- Nvidia
- ARM
- Vivante
- ...

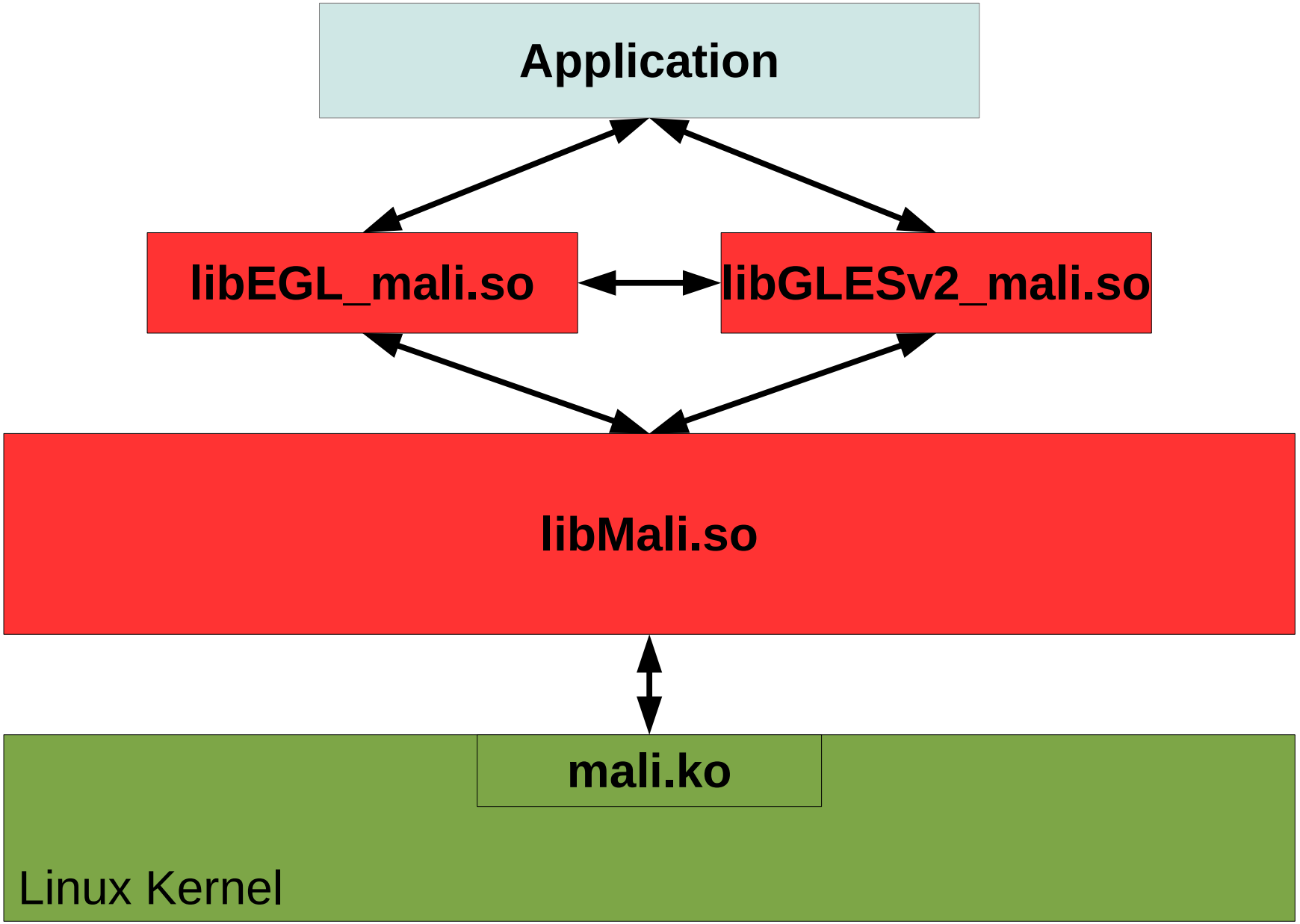

Mali™-200
Vertex Processor
Fragment Processor
Memory Management Unit
AMBA® 3 AXI3™ Interface


Mali™-400MP
Vertex Processor
Fragment Processor
Fragment Processor
Fragment Processor
Fragment Processor
Memory Management Unit
Level 2 Cache
AMBA® 3 AXI3™ Interface

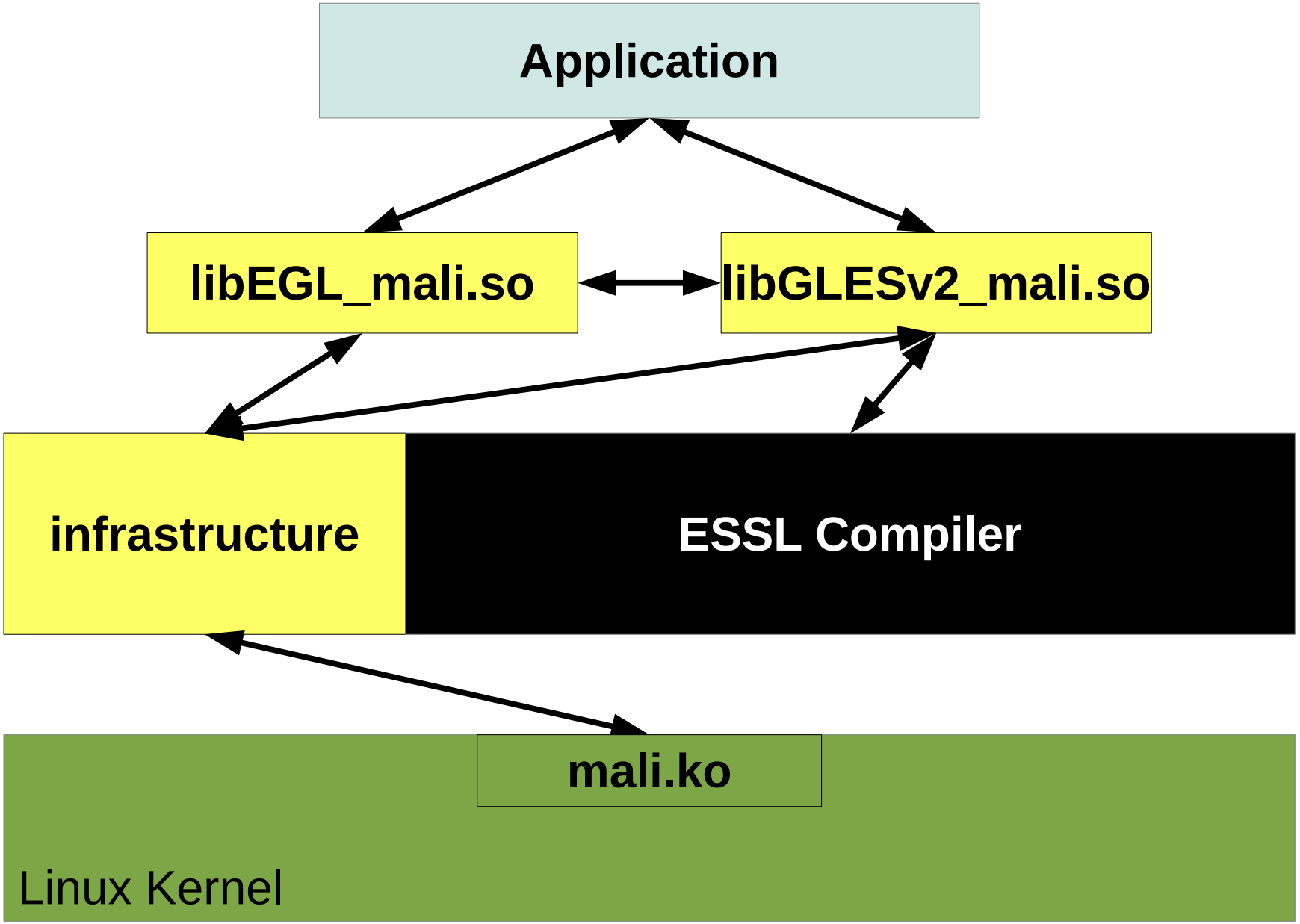
Availability?

- Mali-200:
  - Telechips 8902
  - Telechips 8803
- Mali-400:
  - Samsung Exynos (Mali-400 MP4)
  - ST/E Novathor
  - Allwinner A10
  - Amlogic 8726-M

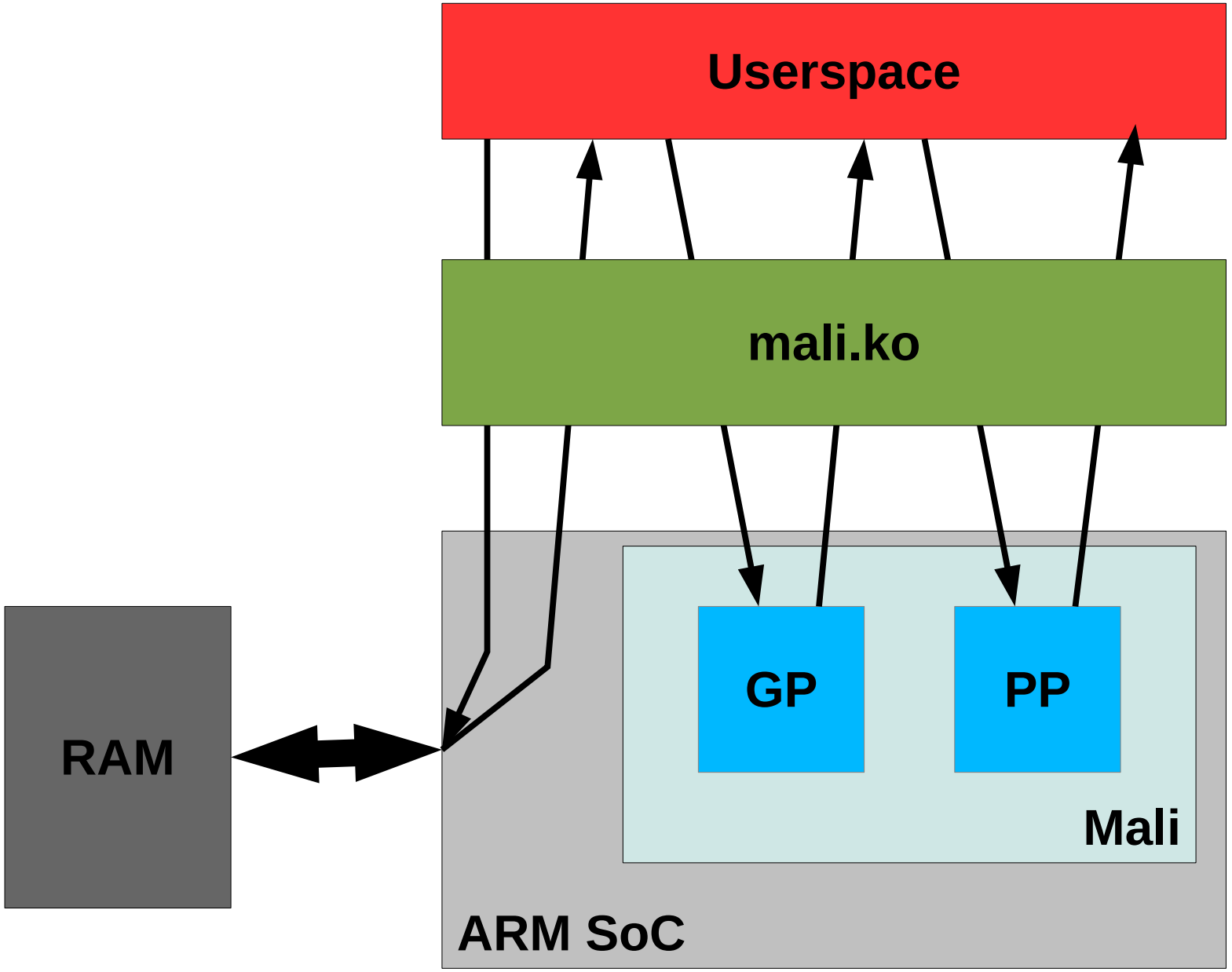
ARM's Mali driver stack



Infrastructure vs Compiler



Userspace-Kernel Interaction



Mali Kernel Interaction

- Retrieve GPU and Memory info
- Map some GPU memory
- [Build up command stream in GPU memory]
- Submit GP job
- Wait for GP job done
- Submit PP job
- Wait for PP job done

All you need is... LD_PRELOAD

To wrap open(), ioctl(), mmap():

- Get /dev/mali fd from open()
- Get memory from mmap()
- At GP job start:
  - Dump GP registers
  - Dump memory
- At PP job start:
  - Dump PP registers

Limare

- Prototyping only!
- Infrastructure work only:
  - Command stream build up
  - Interface with compiler
  - Linker
  - Job handling
- Small, single frame, tests
- Dumps render to .bmp and fbdev

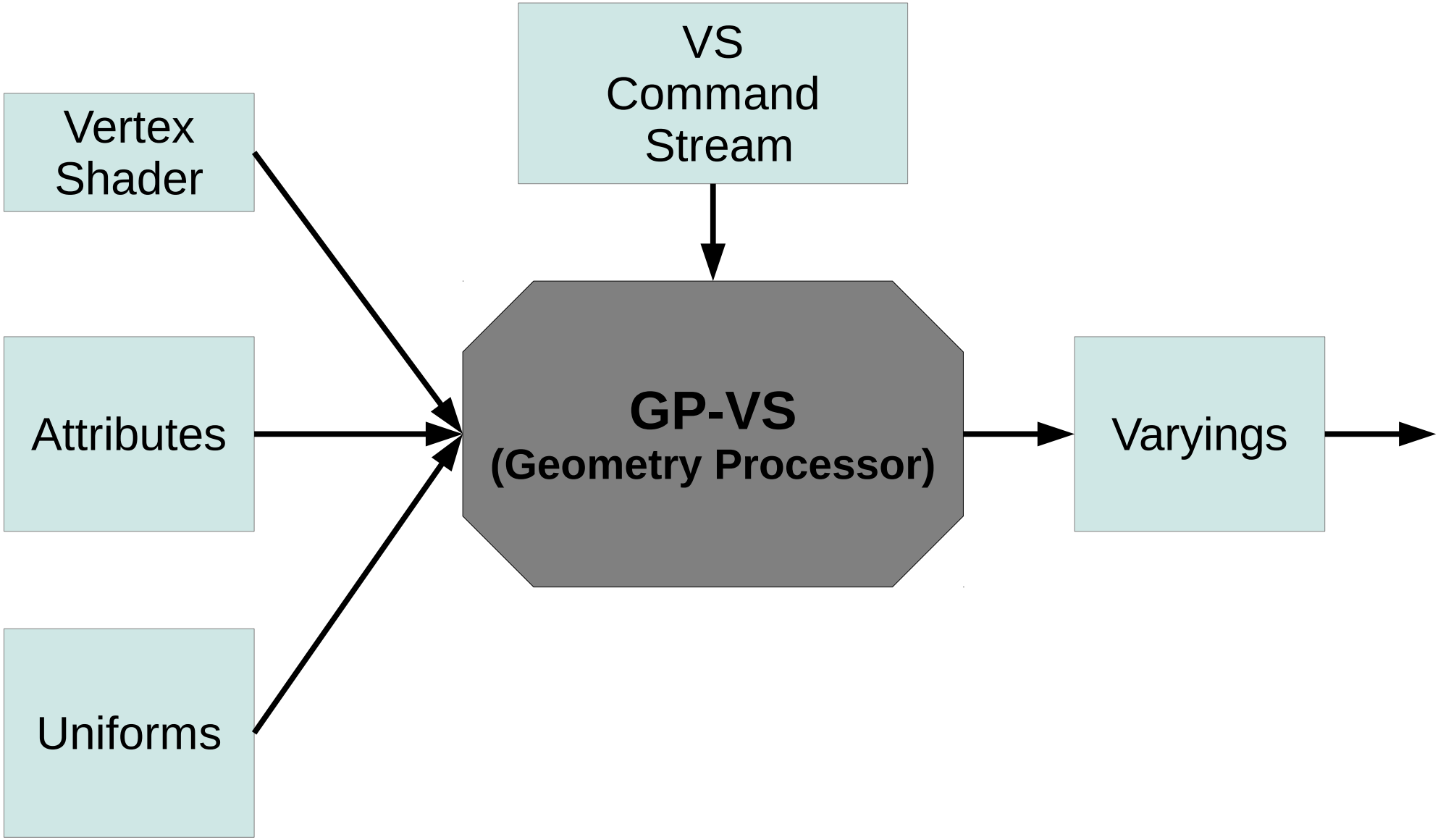
Limare Methodology

1) Create single frame GLES application
2) Capture command stream
3) Replay command stream
4) Reduce and analyze command stream
5) Adjust Limare infrastructure
6) goto 1

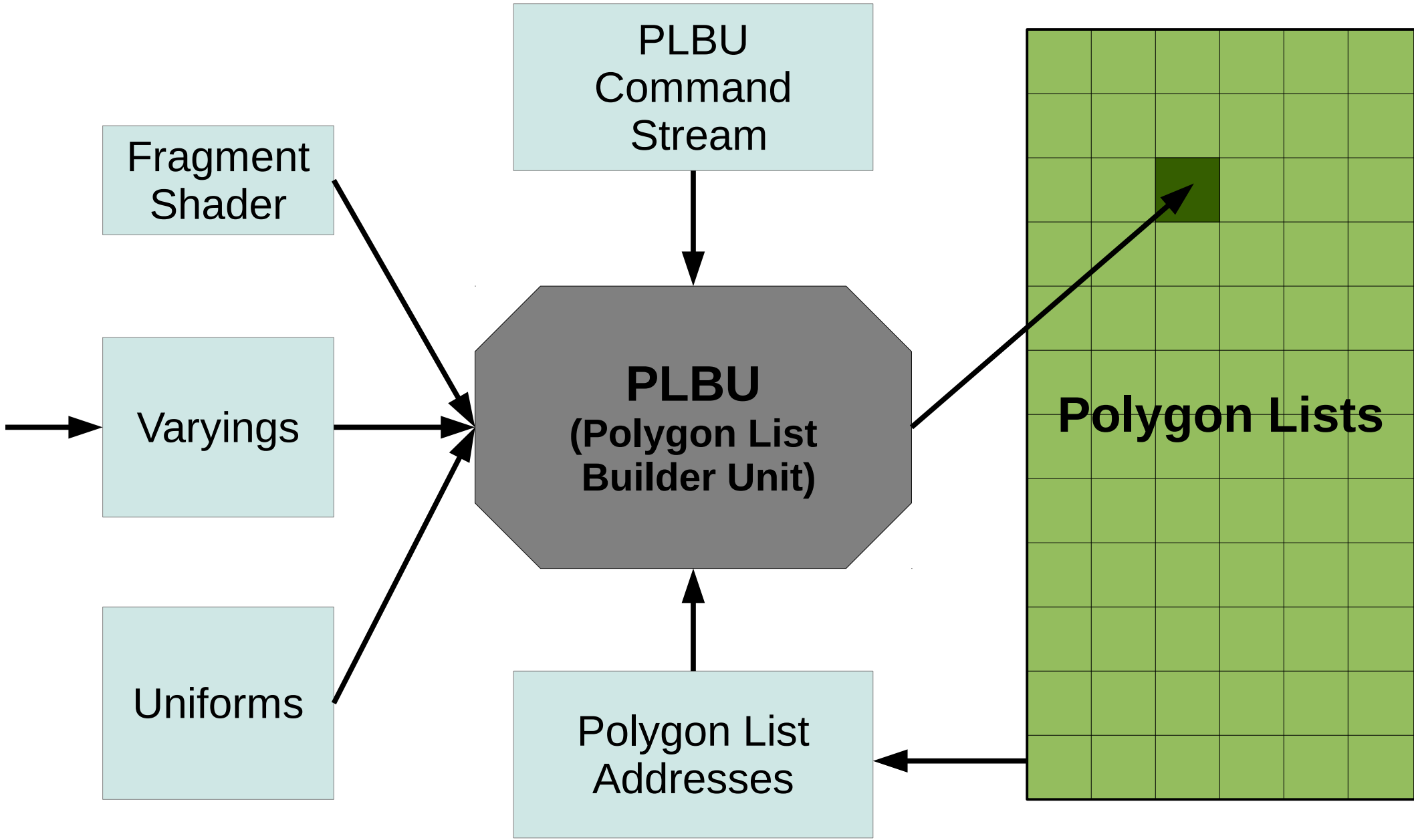
Status: Working

- Mali-200 and Mali-400
- Render to any size the HW supports
- Shader linking
- Assignment of Uniforms, attributes, varyings
- Multiple draws.
- Android app

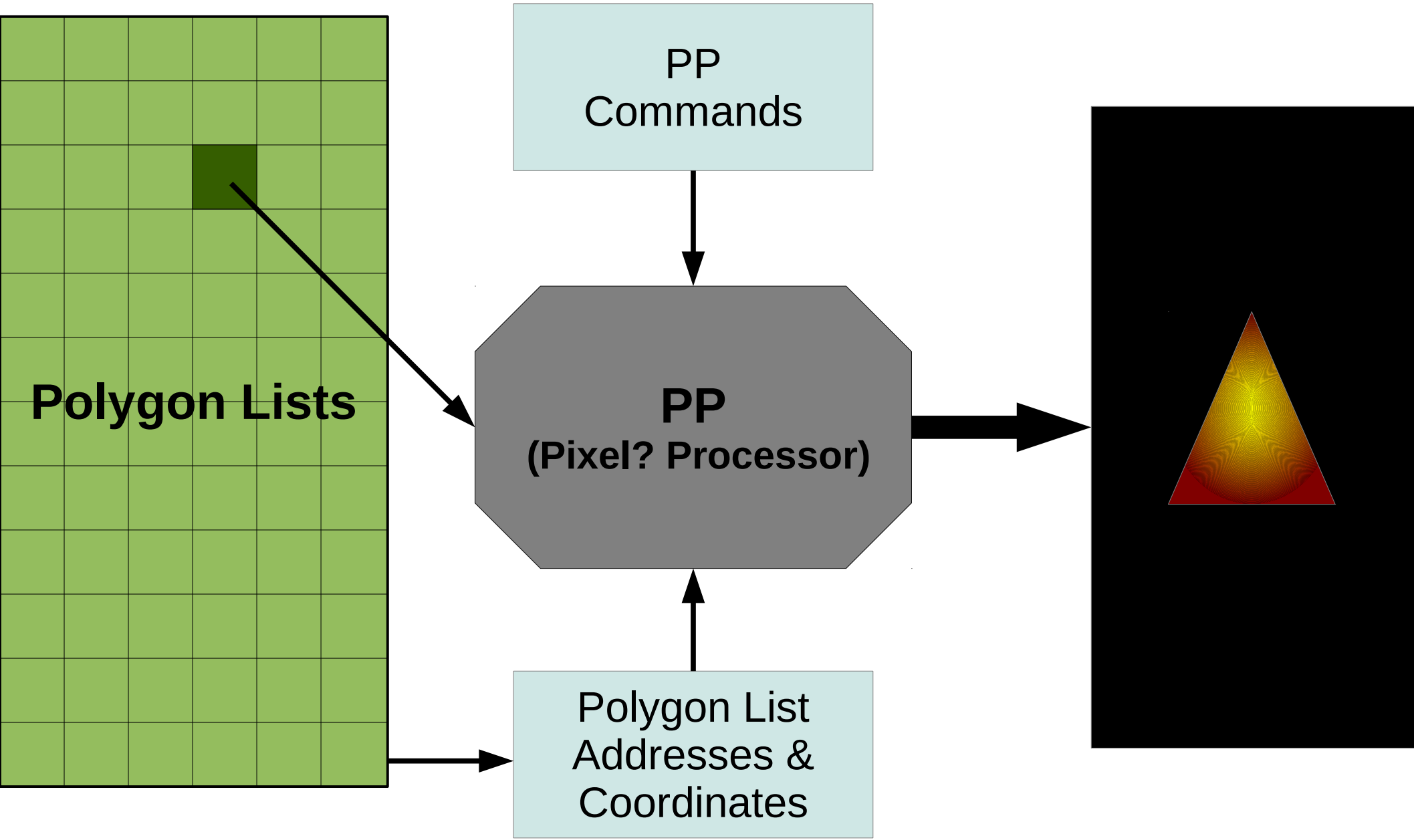
GP - Vertex


VS
Command
Stream
Vertex
Shader
Attributes
Uniforms
GP-VS
(Geometry Processor)
Varyings

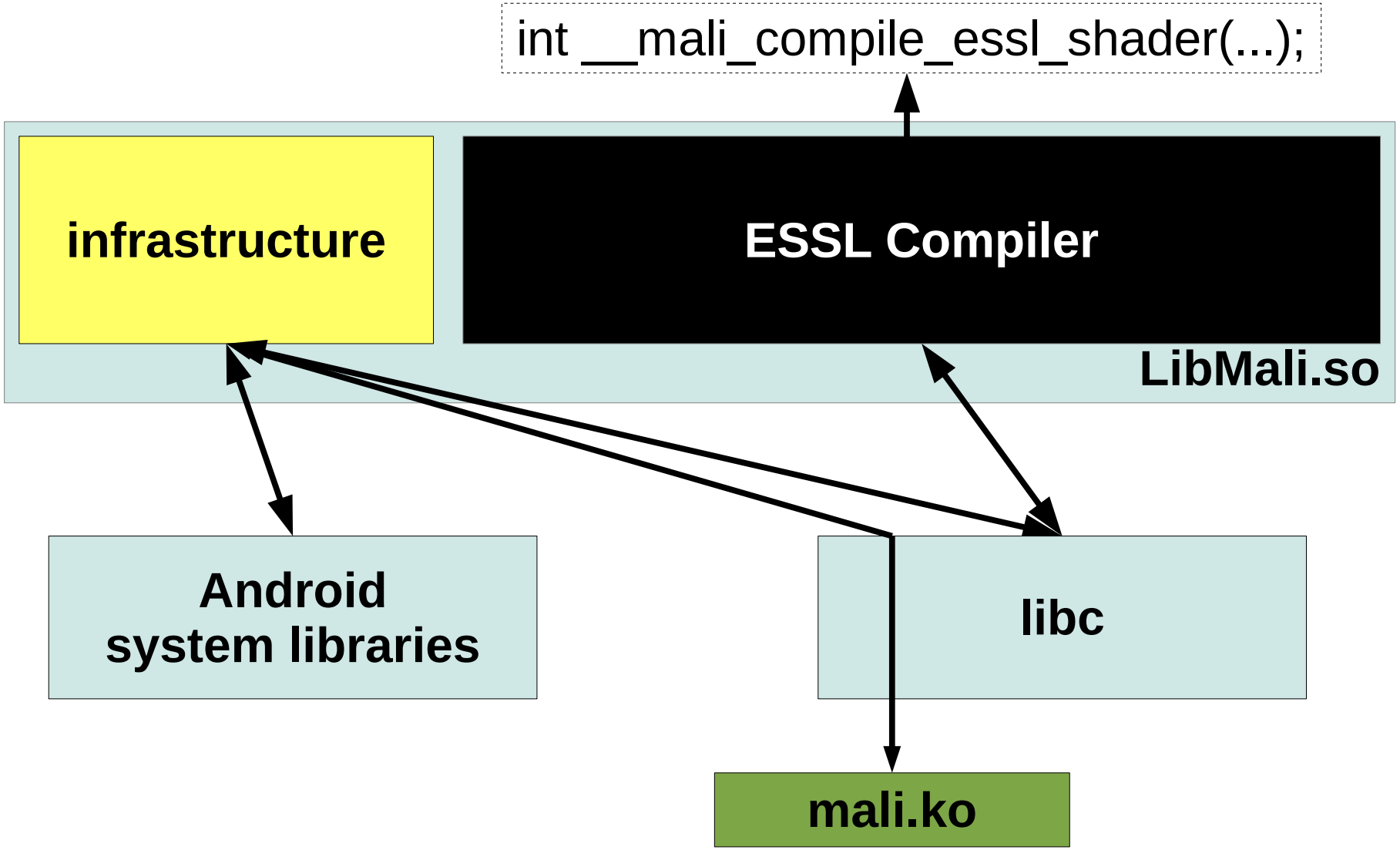
GP - PLBU


PLBU
Command
Stream
Fragment
Shader
Varyings
Uniforms
PLBU
(Polygon List
Builder Unit)
Polygon Lists
Polygon List
Addresses

PP


PP
Commands
Polygon Lists
PP
(Pixel? Processor)
Polygon List
Addresses &
Coordinates

Compiler


int __mali_compile_essl_shader(...);
infrastructure
ESSL Compiler
LibMali.so
Android
system libraries
libc
mali.ko

Binary Shader Compiler?

- Depends only on libc
- No setup needed
- Single function call
- Needs source, shader type, 1 struct

→ Quick and easy standalone usage!

Shader instructions

- 128bit VLIW
- Fixed structure

  vertex: Varying and attribute positions are known
- ? Work for both Mali-200 and Mali-400 ?
- … [TODO]

Up Next!

- Textures
- Kick-start shader instruction RE-ing
- Setting depth, cull directions, etc...
- More tests/demos!
- Build system, basic memory management, documentation...
- Multiple frames?

Future

- Gallium driver with binary compiler
  - 2-4Months
  - “Should” match performance
- Gallium driver with open compiler
  - Depends...
- DRM driver
  - Next 6 months: Counterproductive
  - Afterwards: Keep old API for compatibility

Contribute!

- Site: http://www.limadriver.org
- Mailinglist: lima@limadriver.org
- Get a device
- Start playing!

http://www.limadriver.org/