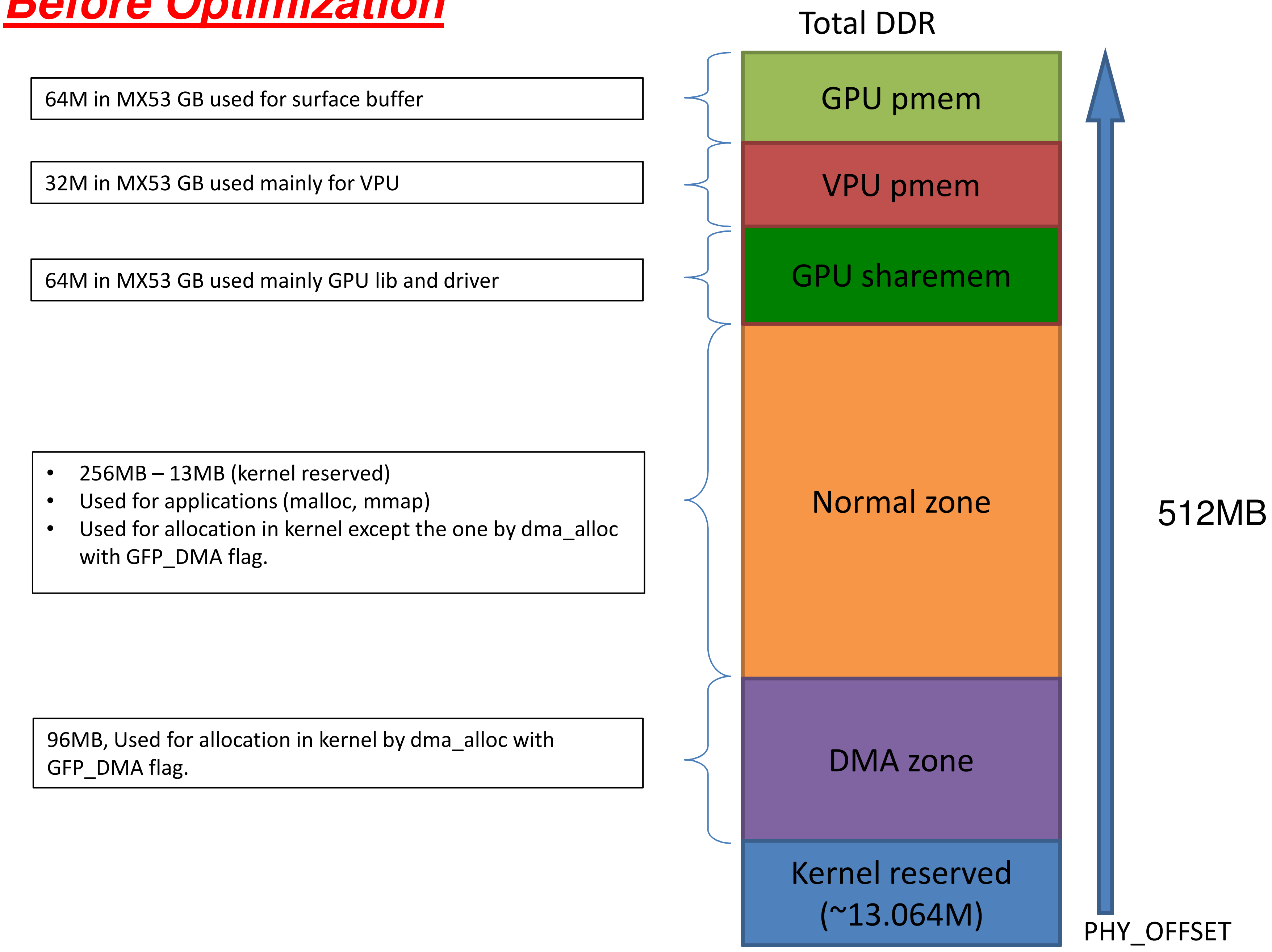
- Memory Issue in i.MX5 Android
  - Too much memory reserved for DMA zone, that user space can not use.
  - High frequency dma_alloc/free with big buffer size in DMA zone on runtime. It causes DMA zone memory fragment, especially on the camera preview/recording switch on HDMI case.
  - GPU driver's poor memory manager to handle allocation for texture, shader, VBO, etc, causes GPU reserved memory fragment. And the use rate of it only around 50% on fragment.
  - All the above fragments will make system function unavailable and not recoverable until reboot.

Before Optimization



Total DDR

GPU pmem

VPU pmem

GPU sharemem

Normal zone

DMA zone

Kernel reserved (~13.064M)

512MB

PHY_OFFSET

64M in MX53 GB used for surface buffer

32M in MX53 GB used mainly for VPU

64M in MX53 GB used mainly GPU lib and driver

- 256MB – 13MB (kernel reserved)
- Used for applications (malloc, mmap)
- Used for allocation in kernel except the one by dma_alloc with GFP_DMA flag.

96MB, Used for allocation in kernel by dma_alloc with GFP_DMA flag.

Memory Analysis - 1

- VPU pmem
  - VPU decoder output video frame buffers
    - Number: 5-19 depends on stream.
    - Size: stream resolution * number
    - Tough example: 1920*1080*1.5*19 = 56M
  - VPU input bitstream buffers on decoding
    - Size: 2M
  - VPU slice buffer
    - Size: stream resolution * 1.5 / 2
  - VPU ps buffers
    - Size: 512K
- GPU pmem
  - Android surface double buffers
    - Size: screen size * bpp/8 * 2 (double) * NUM_LAYERS_MAX (31 by default)

Memory Analysis - 2

- GPU share memory (The size can not be estimated)
  - Pbuffer (not usual on android)
  - Texture (the biggest consumer and no upper limit)
  - VBO (Vertex buffer object)
  - Shader (not big in general)
  - Command buffer (about 64K)
  - Auxiliary buffer (for tiling texture and others)

Memory Analysis - 3

- <u>DMA zone</u>
  - Misc: USB, FEC, audio record driver (get on boot)
  - VPU driver
    - VPU lib internal buffers
      - Working buffer
        - Size: 8 (instances) x 128K = 1M
      - firmware code buffers
        - Size: 520K
    - Share memory buffer
      - Size: 2M

- DMA zone (continue)
  - Framebuffer display triple buffers
    - fb0 (main display), fb1 (second display), fb2 (overlay)
    - Size: fb0/2 = main screen size * bpp/8 * 3. fb1 = second screen size * bpp/8 * 3
  - IPU lib working buffers for doing rotation
    - Size: overlay surface size * bpp/8
  - V4L2 output display triple buffer
    - Size: screen size * bpp/8 * 3

- DMA zone (continue)
  - V4L2 capture
    - CSI dummy buffer for first frame (preview/encoding)
      - Size: preview/encoding size
    - YUV buffers on encoding to VPU
      - Num: 5
      - Size: 5 * record frame size
    - YUV buffers on capture
      - Num: 3
      - Size: 3 * capture frame size
    - YUV buffers on preview
      - Num: 5
      - Size: 6 * preview frame size

Optimization - 1

- Replace the alloc method by dma_alloc with pmem allocator for most of the buffers
  - Reserve the fb(x) triple buffers on kernel boot
  - Replace the usage of V4L2 output with FB2 triple
  - Replace the usage of Camera YUV buffers with pmem
  - Replace the usage of VPU driver internal buffers with pmem
  - Replace the usage of VPU share memory with vmalloc
  - Replace the usage of IPU lib rotation buffer with pmem
  - Allocate the suitable buffer for CSI dummy frame on first use of v4l2.

Optimization - 2

- GPU share memory
  - Let GPU user lib to manage small and unaligned memory blocks instead of GPU share memory manager in driver.
  - Add best fit algorithm to the driver's memory manager.
- Remove Normal zone
  - To let more memory for user space use

After Optimization

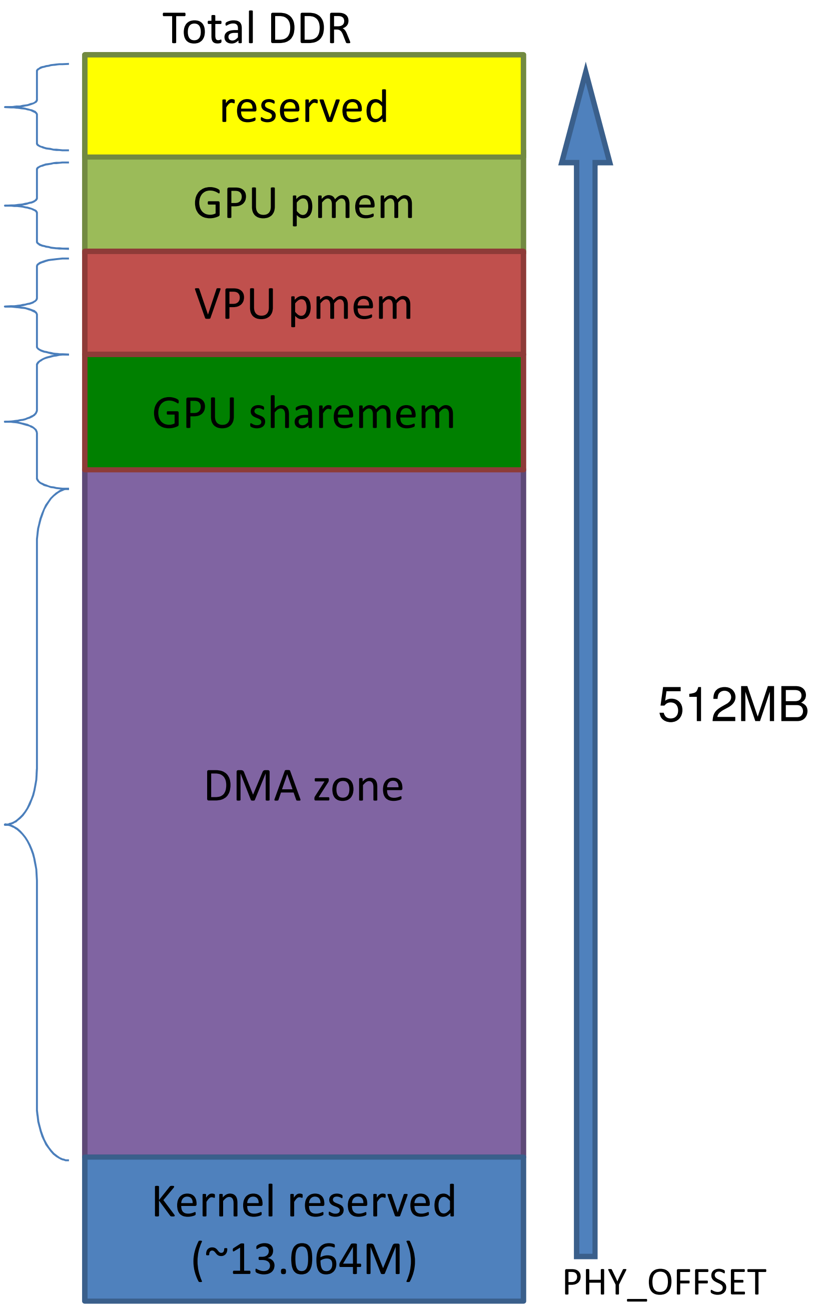
40M in MX53 GB used for fb buffers

64M in MX53 GB used for surface buffer

64M in MX53 GB used mainly for VPU and Camera preview/recording YUV buffer

64M in MX53 GB used mainly GPU lib and driver

- 280MB - 13MB
- Used for applications (malloc, mmap)
- Used for allocation in kernel, also for the one by dma_alloc with GFP_DMA flag.



Total DDR

reserved

GPU pmem

VPU pmem

GPU sharemem

DMA zone

Kernel reserved (~13.064M)

512MB

PHY_OFFSET