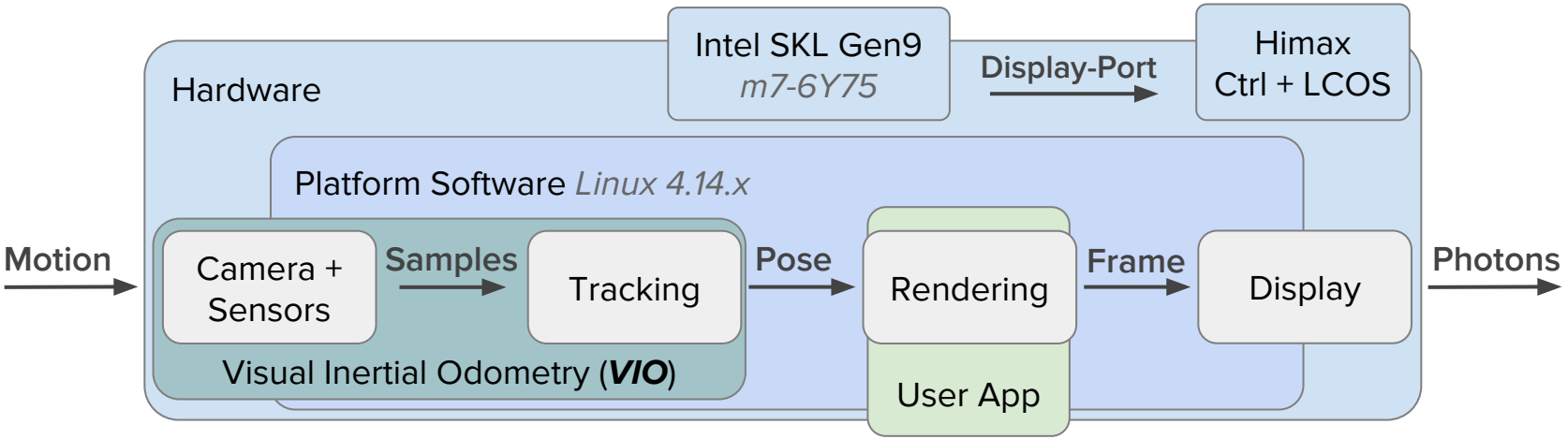
Optimizing Motion-to-Photon Latency

on DAQRI Smart Glasses

Heinrich Fink
heinrich.fink@daqri.com

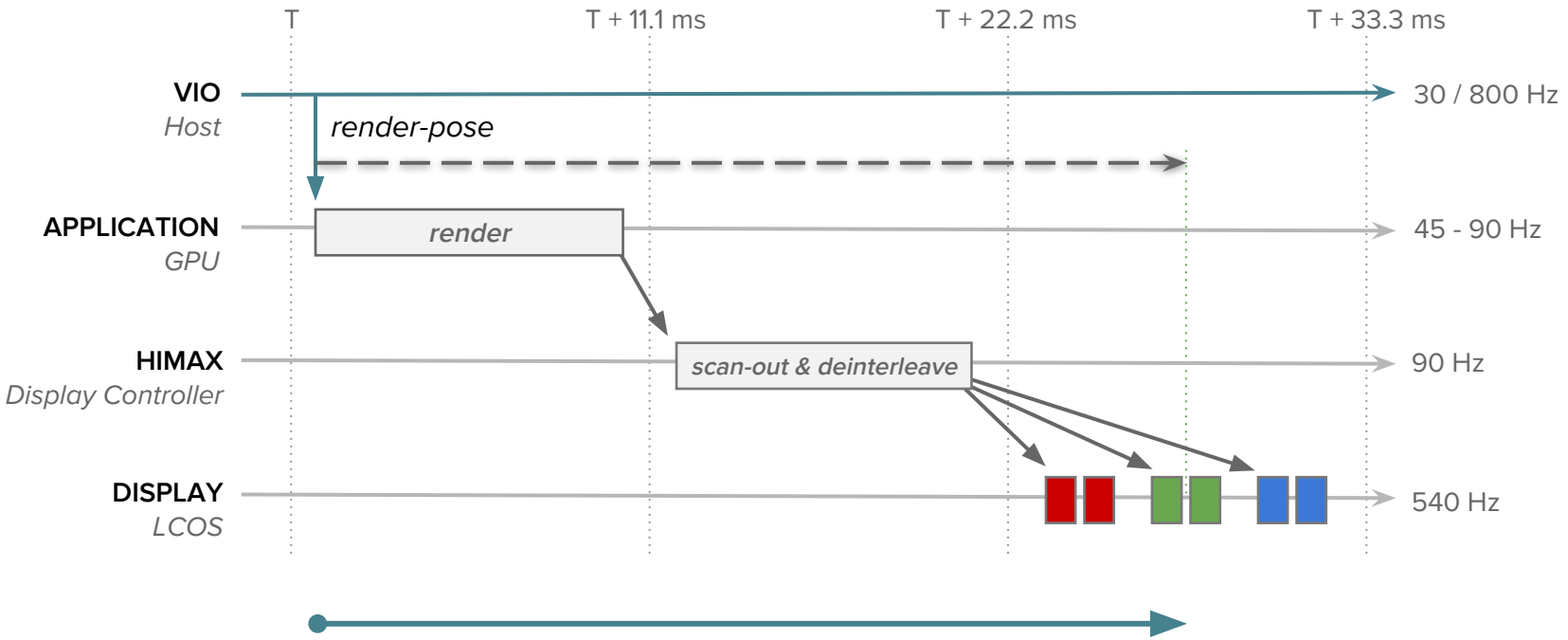
XDC 2018

System Overview



Ideal ***motion-to-photon*** *latency:* ***AR < 5 ms*** [1,3]
VR < 20 ms [2]

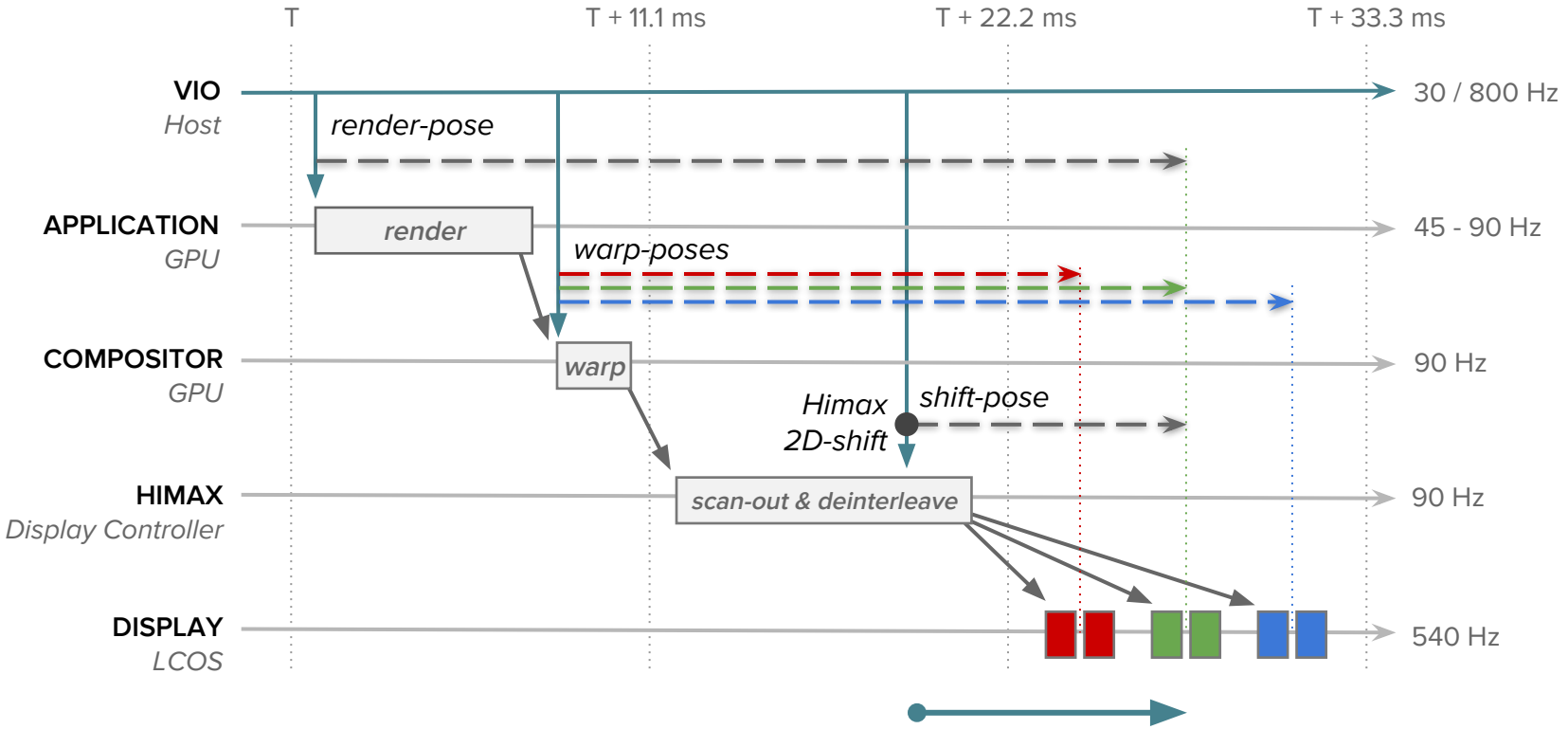
Demo :: Basic Mode



Motion-to-photon latency: ***~ 26 ms***

different for each color → rainbow effect

Demo :: Optimized Mode



Challenges of AR Compositor Architecture

- Custom interface between App and Compositor
  - Need to attach pose / time to app render buffer (for downstream)
  - Let compositor pace app render cycles
  - Decouple render-rate from display-rate
  - No prevalent standard exists for that (yet?)
- Keep end-to-end pipeline short
  - No triple buffering, no intermediates
  - Updating poses as late as possible w/o stalling the full pipeline
- Compositor/App compete for GPU resources
  - Pre-emption likely needed

The Path Ahead

- Remove the desktop render path
  - Direct use of KMS to flip / access timing info
- Use DRM format modifiers for optimal end-to-end buffer formats
  - Can import into EGL / Vulkan for applications
- Use dma_fence for down/up stream synch and traceability
- Use KMS-exposed hardware planes for simple compositing
  - Although varying timing requirements might be tricky
- Observability through standard tools (GPUView, GPUtop, ...?)

References

[1] Bailey, R. E., Arthur, J. J., & Williams, S. P. (2004, August). Latency requirements for head-worn display S/EVS applications. In Enhanced and Synthetic Vision 2004 (Vol. 5424, pp. 98-110). International Society for Optics and Photonics.

[2] Yao, R., Heath, T., Davies, A., Forsyth, T., Mitchell, N., & Hoberman, P. (2014). Oculus vr best practices guide. Oculus VR, 4. http://static.oculusvr.com/sdk-downloads/documents/OculusBestPractices.pdf

[3] Lincoln, P. C. (2017). Low Latency Displays for Augmented Reality (Doctoral dissertation, The University of North Carolina at Chapel Hill).

[4] Presentation about [3] : https://www.microsoft.com/en-us/research/video/low-latency-displays-augmented-reality/

[5] Wagner, D., (2018). MOTION TO PHOTON LATENCY IN MOBILE AR AND VR, https://medium.com/@DAQRI/motion-to-photon-latency-in-mobile-ar-and-vr-99f82c480926