



Vision Acceleration

April 2013

Khronos Connects Software to Silicon

ROYALTY-FREE, OPEN STANDARD APIs
for advanced hardware acceleration

Graphics, video, audio, compute,
visual and sensor processing

Low level silicon to software interface
needed on every platform

Defines the forward looking roadmap
for the silicon community

Shipping on billions of devices across
multiple operating systems

Rigorous conformance tests for
cross-vendor consistency

Khronos is OPEN for any company to
join and participate

Acceleration APIs BY the Industry
FOR the Industry



Interesting Mobile Use Cases use CAMERA



**Computational
Photography**



**Face, Body and
Gesture Tracking**



**3D Scene/Object
Reconstruction**



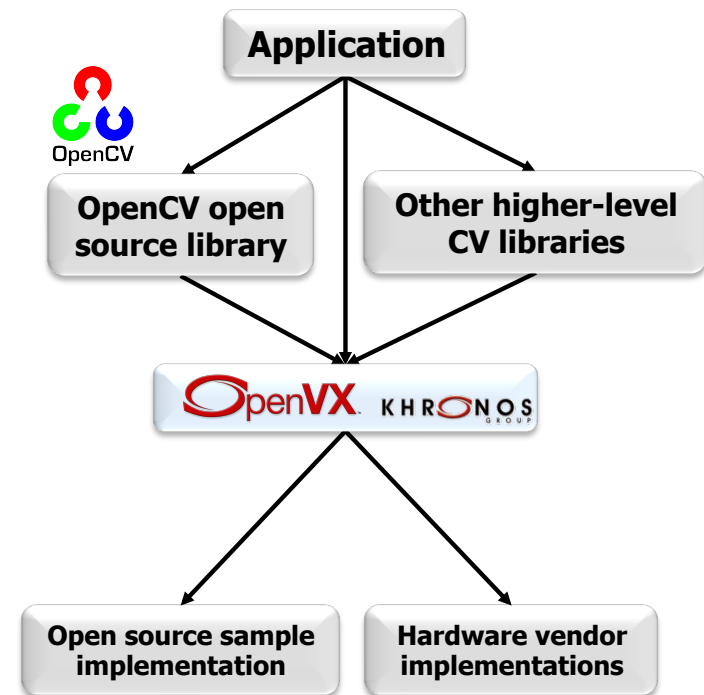
**Augmented
Reality**

Time →

OpenVX

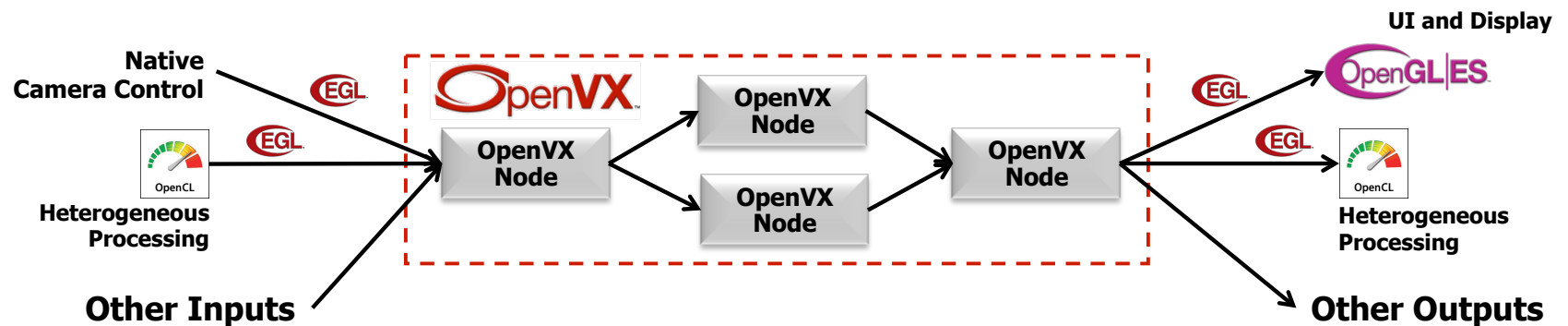
- **Vision Hardware Acceleration Layer**
 - Enables hardware vendors to implement accelerated imaging and vision algorithms
 - For use by high-level libraries or apps
- **Focus on enabling real-time vision**
 - On mobile and embedded systems
- **Diversity of *efficient* implementations**
 - From programmable processors, through GPUS to dedicated hardware pipelines

Dedicated hardware can help make vision processing performant and low-power enough for pervasive 'always-on' use





OpenVX Execution Flow

- **OpenVX Graph for efficient execution**
 - Each Node can be implemented in software or accelerated hardware
 - Data transfer between nodes may be optimized
- **EGL can provide data and event interop with other APIs – with streaming**
 - BUT use of other Khronos APIs are not mandated
- **VXU Utility Library provides efficient access to single nodes**
 - Open source implementation – easy way to start using OpenVX



OpenVX and OpenCV are Complementary

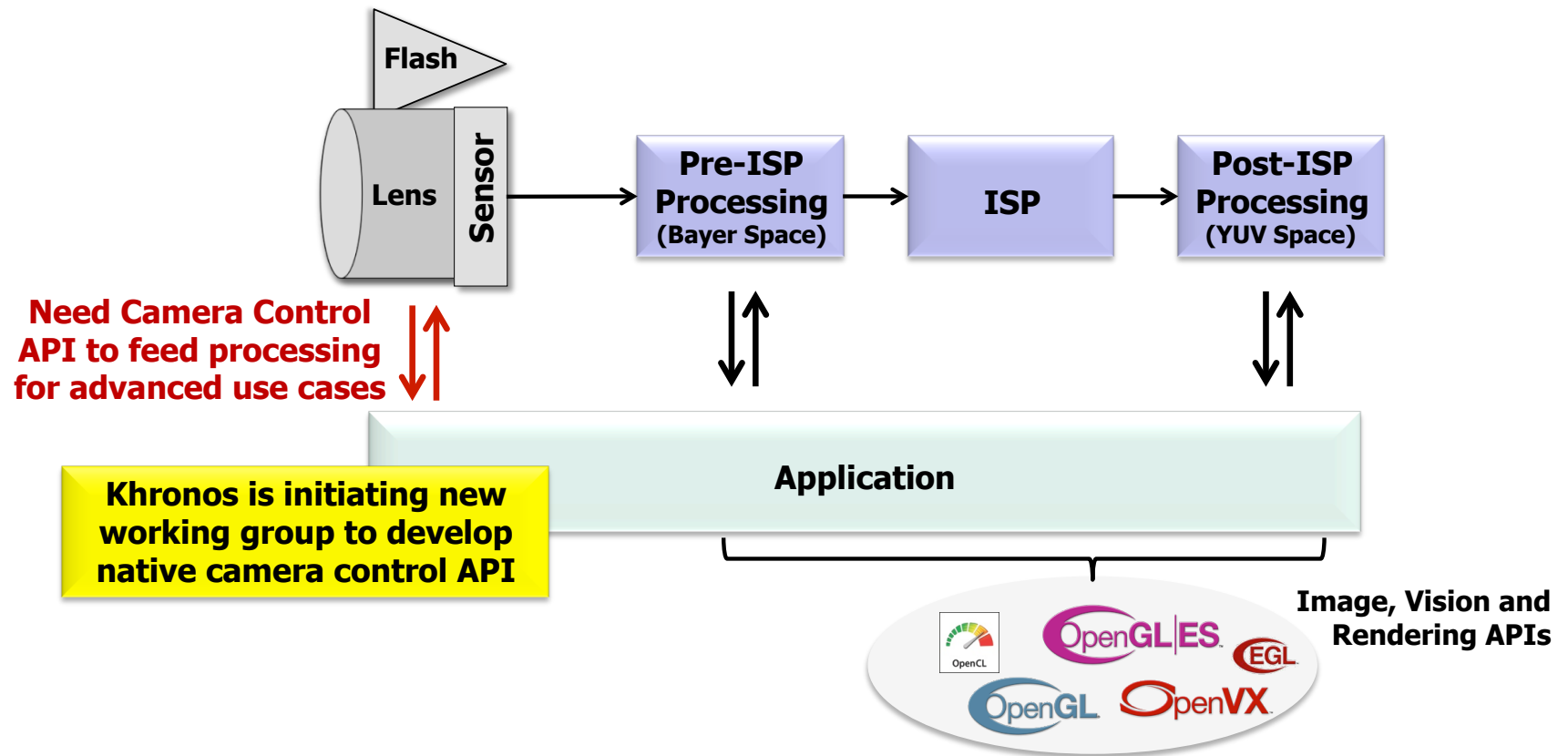
	 OpenCV	
Governance	Open Source Community Driven No formal specification	Formal specification and full conformance tests Implemented by hardware vendors
Scope	Very wide 1000s of functions of imaging and vision Multiple camera APIs/interfaces	Tight focus on hardware accelerated functions for mobile vision Use external camera API
Efficiency	Memory-based architecture Each operation reads and writes memory Sub-optimal power / performance	Graph-based execution Optimized nodes and data transfer Highly efficient
Conformance	No Conformance testing Every vendor implements different subset	Full conformance test suite / process Reliable acceleration platform
Use Case	Rapid prototyping	Production deployment

OpenVX Participants and Timeline

- Aiming for specification before end of 2013
- Itseez is working group chair
- QC/TI are specification editors



Breaking News!



Khronos is initiating new working group to develop native camera control API

Advanced Camera API Use Cases

- **High-dynamic range (HDR) and computational flash photography**
 - High-speed burst with individual frame control over exposure and flash
- **Rolling shutter elimination**
 - High-precision synchronization with motion sensor data
- **HDR Panorama, photo-spheres**
 - Continuous frame capture with constant exposure and white balance
- **Subject isolation and depth detection**
 - High-speed burst with individual frame control over focus
- **Augmented Reality**
 - 60Hz, low-latency capture with motion sensor synchronization
 - Multiple Region of Interest (ROI) capture
 - Multiple sensors for scene scaling
 - Detailed feedback on camera operation per frame

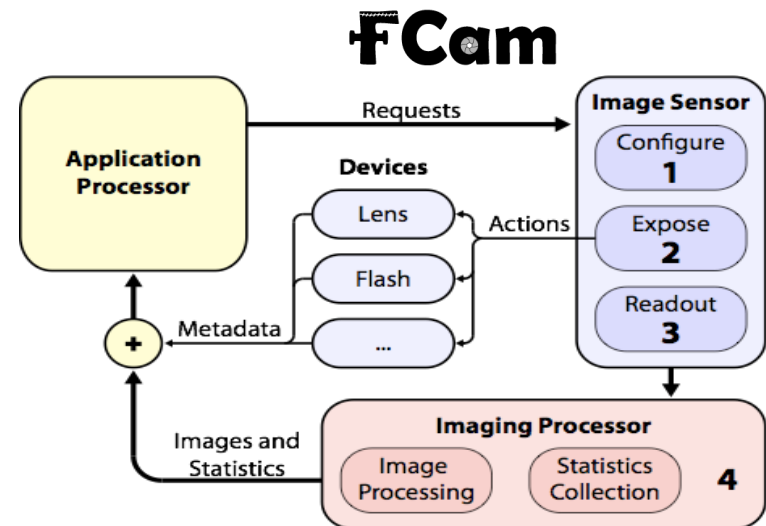
Existing APIs as Starting Point

- **FCAM – Open source project**

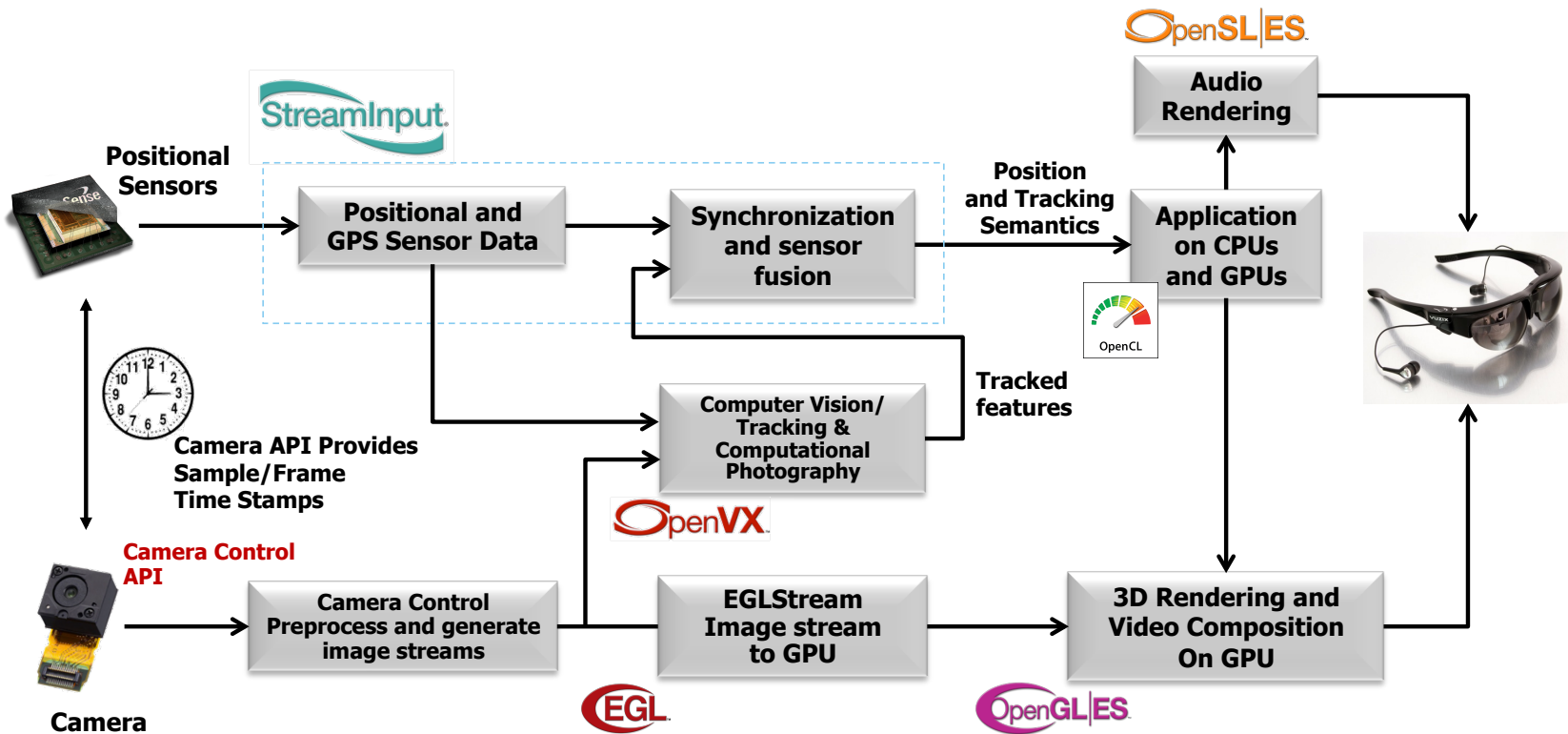
- Capture of stream of camera images with precision control
 - A pipeline that converts requests into image stream
 - All parameters packed into the requests - no invisible state
 - Programmer has full control over sensor settings for each frame in stream
- Control over focus and flash
 - No hidden daemon running
- Control ISP
 - Can access supplemental statistics from ISP if available

- **Android New Camera HAL (2013)**

- Uses some of these concepts

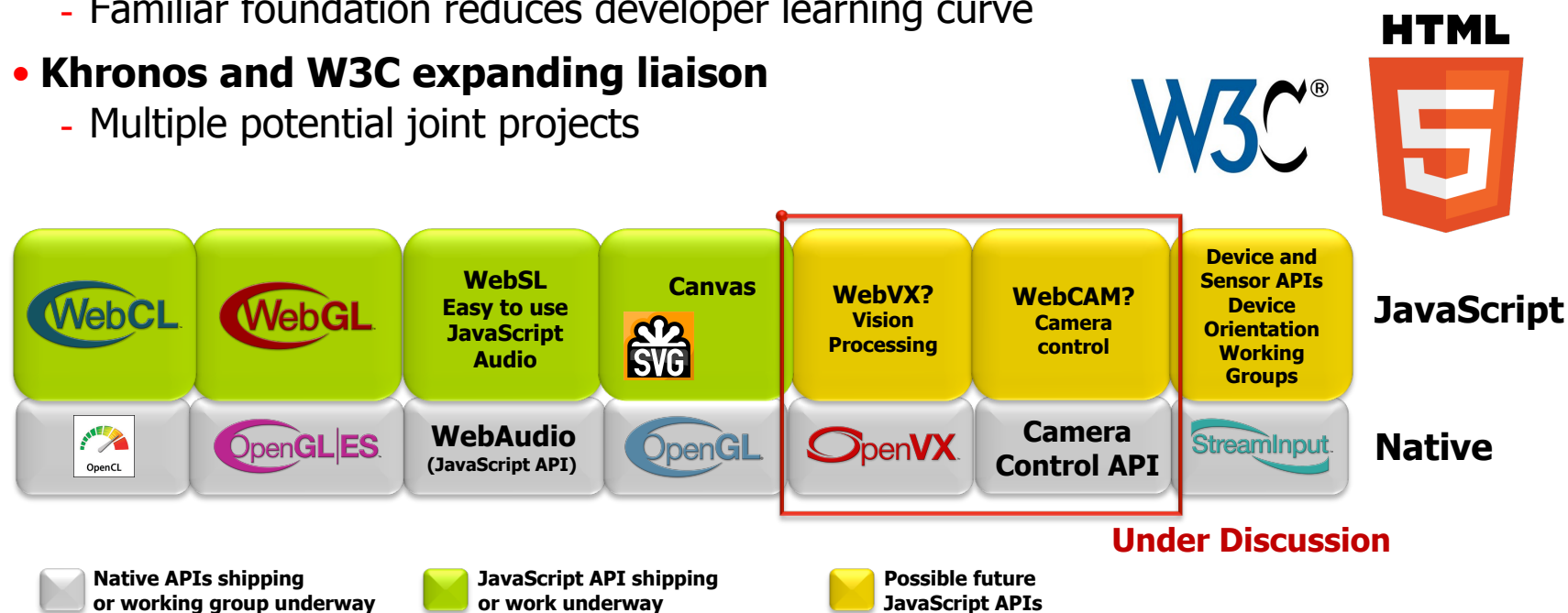


Example use of Khronos APIs in AR



Leveraging Proven Native APIs into HTML5

- **Leverage native API investments into the Web**
 - Faster API development and deployment
 - Familiar foundation reduces developer learning curve
- **Khronos and W3C expanding liaison**
 - Multiple potential joint projects



Summary

- **Khronos is developing APIs for advanced camera control and vision processing to enable apps to tap into silicon acceleration**
- **Sensor and vision processing now just as important as graphics and compute acceleration**
- **Cooperation between hardware and software communities needed to deliver compelling mobile vision processing in a fixed power budget**
- **If this is relevant to your business – please consider joining Khronos to participate in the development of these important standards**
- **www.khronos.org**

