Embedded Camera System API
Working Group Update, November 2022

What is Kamaros

EMBEDDED CAMERA SYSTEM API

Jointly promoted by Khronos and the European Machine Vision Association (EMVA), the Kamaros API Working Group is now developing an open, royalty-free standard for controlling camera system runtimes in embedded, mobile, industrial, XR, automotive, and scientific markets

The Need for a Camera System API Standard

Increasing Sensor Diversity
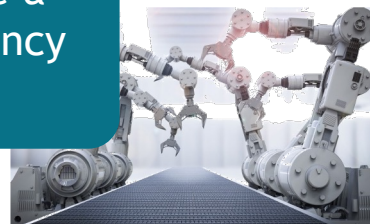Including camera arrays and depth sensors such as Lidar

Multiple Sensors Per System
Synchronization and coordination become essential

The cost and time to integrate and utilize sensors in embedded systems has become a major constraint on innovation and efficiency in the embedded vision market

Increasing Sensor Processing Demands
Including inferencing. Sensor outputs need to be flexibly and efficiently generated and streamed into acceleration processors
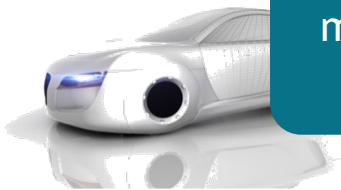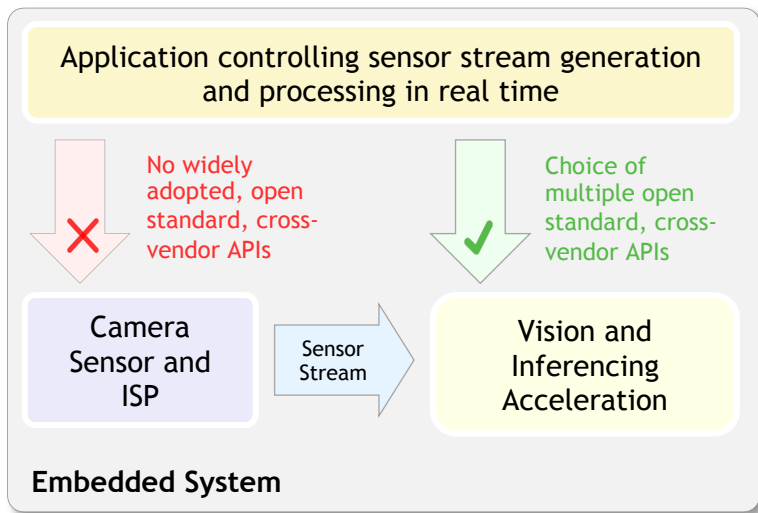
Proprietary APIs Hinder Innovation
Vendor-specific APIs to control cameras, sensors and close-to-sensor ISPs prevent rapid integration of new technologies

Benefits of Embedded Camera API Standard

An effective open, cross-vendor open standard for camera, sensor and ISP control could provide multiple benefits

| Application controlling sensor stream generation and processing in real time |

No widely adopted, open standard, cross-vendor APIs ✗

Choice of multiple open standard, cross-vendor APIs ✓

Camera Sensor and ISP → Sensor Stream → Vision and Inferencing Acceleration

Embedded System

Cross-vendor portability of camera/sensor code for easier system integration of new sensors
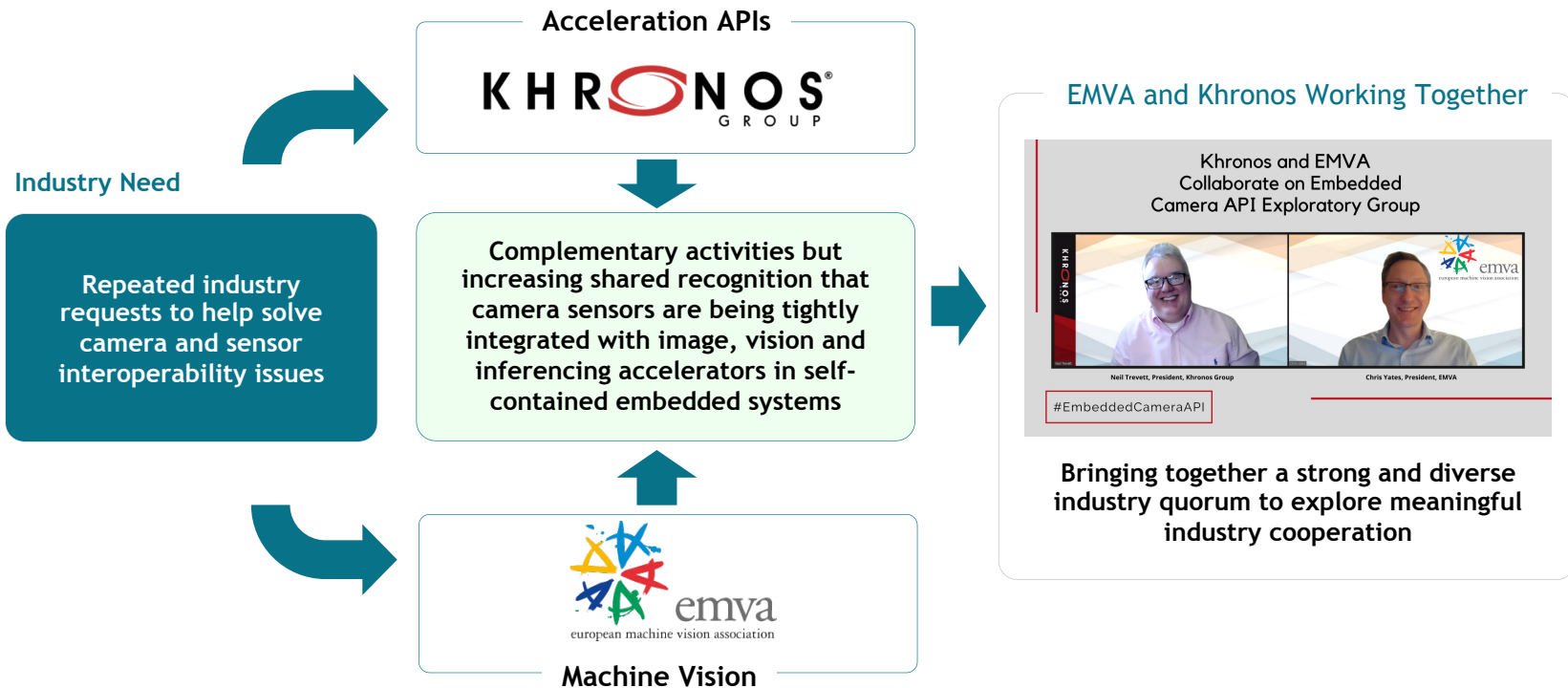
Preservation of application code across multiple generations of cameras and sensors

Sophisticated control over sensor stream generation increases effectiveness of downstream accelerated processing

Development of Camera and sensor APIs may also generate new requirements for downstream vision and inferencing acceleration APIs

Genesis of Embedded Camera API Initiative

Significant industry interest indicated the time may be right for a standardization initiative

Acceleration APIs

KHRONOS GROUP®

Industry Need

Repeated industry requests to help solve camera and sensor interoperability issues

Complementary activities but increasing shared recognition that camera sensors are being tightly integrated with image, vision and inferencing accelerators in self-contained embedded systems

emva
european machine vision association

Machine Vision

EMVA and Khronos Working Together

Khronos and EMVA Collaborate on Embedded Camera API Exploratory Group

Neil Trevett, President, Khronos Group — Chris Yates, President, EMVA

#EmbeddedCameraAPI

Bringing together a strong and diverse industry quorum to explore meaningful industry cooperation

The Road to Camera API Standardization

At the AutoSensONLINE 2021 event panellists from Khronos, EMVA, and members of the original Camera Exploratory Group discussed how a consistent set of interoperability standards and guidelines for embedded cameras and sensors will help solve the problems impeding growth in advanced sensor deployment.

https://www.youtube.com/watch?v=vi7T9EemM-I

The Journey So Far

Feb 2021 ▶ **Dec 2021** ▶ **Mar 2022** ▶ **Nov 2022** ▶ **2023**

Camera API Exploratory Group

In response to industry requests the EMVA and Khronos create a group to explore industry interest for an open camera API standards, and consensus on use cases and requirements

Over 70 companies join and contribute to the discussions and approve the proposed scope of work

Scope of Work

Exploratory group publishes the scope, requirements and design methodology for a new open standard Camera System API

Kamaros

Kamaros

Kamaros name adopted for Working Group and API

Draft Spec

Expected release of draft 1.0 specification for community feedback

Camera Working Group

Working Group formed under the Khronos membership and IP framework. Work starts on the detailed specification of the API, guided by the scope of work

The Scope of Work

- **Approved by Exploratory Group vote on 8th December 2021**

- **The work of the Exploratory Group concluded that:**
  1. There is sufficient need to develop a cross-market camera system API
  2. Existing standards and interfaces did not provide all the necessary features required
  3. Sufficient cross industry support for the development of a new API

- **73 companies participated in the exploratory group**

Adimec Almotive Alexey Kynazev ALL3D, Inc. Allied Vision Technologies GmbH Almalence Inc. AMD Analog Devices Inc. Apertus AREA Arm Limited AVAL DATA CORPORATION Axis Communications AB Basemark Oy Basler AG Baumer Optronic GmbH Cadence Design Systems, Inc. Caster Communications, Inc. China Daheng Group, Inc. Beijing Image Vision Technology Branch Codeplay Collabora Continental Automotive GmbH Digica Solutions Digital Air Technologies Digital Media Professionals Euresys European Machine Vision Association FLIR Integrated Imaging Solutions FOVE Global Nomad GIS Services Google Groget GuangDong OPPO Mobile Telecommunications Corp., Ltd. EMVA Khronos Camera API Working Group Scope of Work Exploratory Group Confidential 7 of 10 Holochip Corporation HP Huawei Technologies Co. Ltd. Ideas on Board Oy Imagination Technologies Institute for Computer Science and Control Intel Jon Leech Khronos Group Kivisense LINX Lucid Vision Labs, Inc. LunarG, Inc. m-lighted SRL MATRIX VISION MIPI Alliance MM Solutions Mobica Ltd MVTec Software GmbH Nokia OYJ NVIDIA Open AR Cloud Association PCO AG Perey Research & Consulting Pinnacle Imaging Systems Pleora Technologies Qtechnology QUALCOMM Raspberry PI Ltd Red Hat, Inc. Rupert Stelz Samsung Sony Corporation STEMMER IMAGING Synopsys Takumi Corporation EMVA Khronos Camera API Working Group Scope of Work Exploratory Group Confidential 8 of 10 Teledyne Texas Instruments VeriSilicon Vision Components
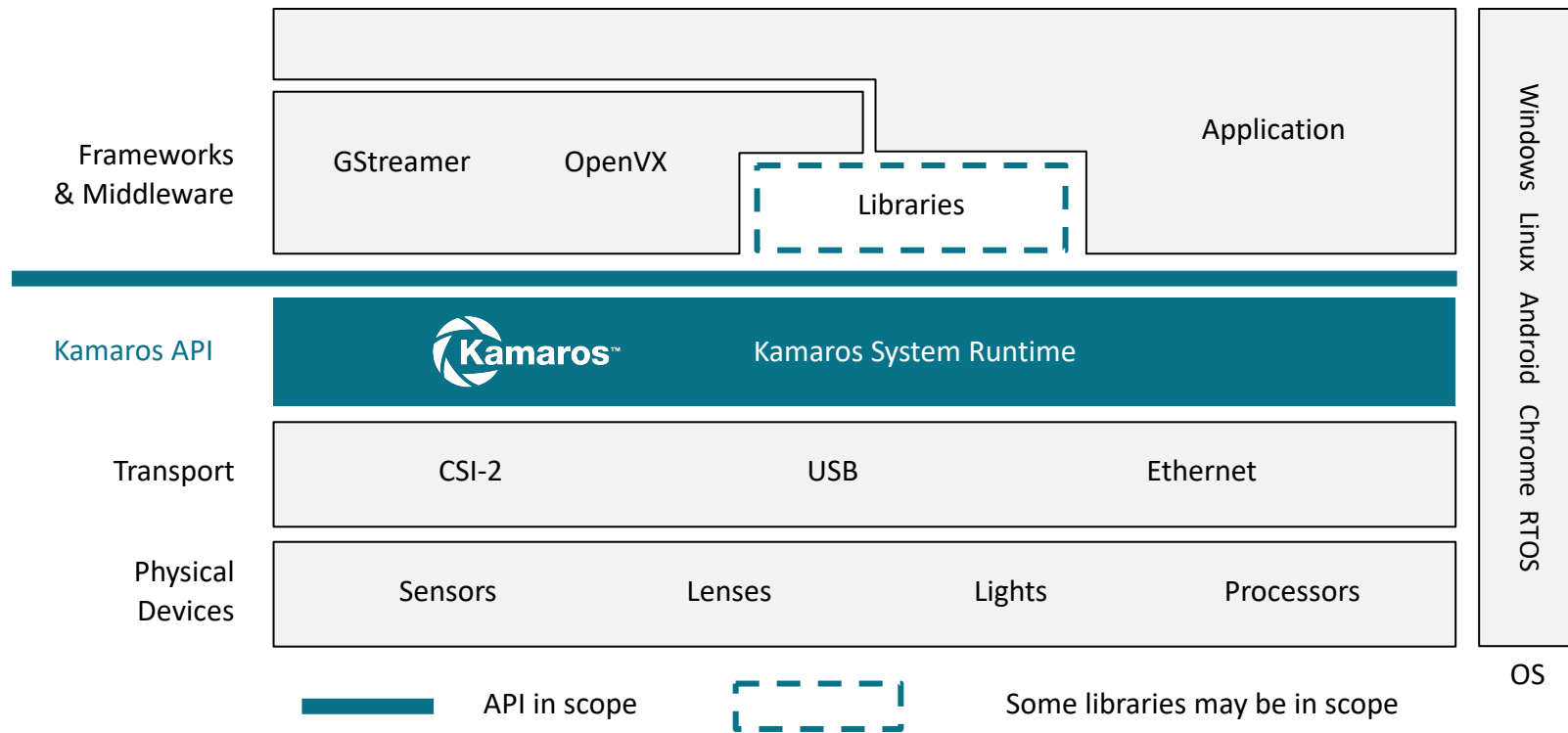
Deliverables

The API shall be made openly available to the industry under royalty-free licensing terms as defined by the Khronos Intellectual Property (IP) Framework

- Working group deliverables shall include:
  - A Camera System API specification for use by implementers of the API, and developers
  - A central extension namespace registry for Working Group and vendor extensions
  - An open source conformance test suite, including a precise definition of conformance
  - An Adopters Program to enable implementations to become officially conformant
  - An API trademark and logo for promotion and use on conformant implementations
  - A conformant portable open-source sample implementation of the API
  - Open source samples and documentation
  - Open source SDK, tools and Libraries

Typical Kamaros Software Stack

Frameworks & Middleware

- GStreamer
- OpenVX
- Libraries
- Application

Kamaros API

Kamaros™ Kamaros System Runtime

Transport

- CSI-2
- USB
- Ethernet

Physical Devices

- Sensors
- Lenses
- Lights
- Processors

Windows Linux Android Chrome RTOS

OS

━━━ API in scope   ┈┈┈ Some libraries may be in scope

Names of transport layers, framework and operating systems are illustrative examples

Industry Call For Participation

Get Involved and Help Shape the Kamaros API

Any organization is welcome to join Khronos and participate in this global initiative under the consortium's multi-company governance process that enables all stakeholders to have a voice in consensus-based working group decisions

For additional information on Kamaros and how to participate as a member visit
www.khronos.org/kamaros

General enquiries   kamaros-feedback@lists.khronos.org
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