TIOVX – TI's OpenVX Implementation

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TI SOC platform – heterogeneous cores

High level processing

- Object detection and tracking
- Classificaiton
- Adaboost, SVM
- KNN, ANN

→ hardware for fully connected and convolution layers

→ General purpose processing for sensor fusion
ARM, DSP

Mid level processing

- Optical Flow
- Stitching
- Integral Image
- Feature Extraction (HOG, SURF, SIFT, ORB,,,)
- Disparity
- Detection of Corners,
- Detection of Edges

→ Specialized hardware units for key sensors
Dense optical flow
Stereo vision
Distortion correction
ISP
Radar processing and acceleration

Low level processing

- Image Signal Processing
- Filtering
- Gradients
- Morphological Operations

→ EVE & DSP Vector Coprocessor:
High Bandwidth
Pixel Operations
SIMD Parallelism
Energy Efficiency

Functional safety compliant architecture | Security | Deep learning acceleration

Scalable s/w and h/w across sensors

TDA platform
Legacy of ASIL D safety - safe island, safe IPs
Legacy of security to implement automotive HSM
hardware for deep convolution network

TIOVX - OpenVX Implementation on TI SoC

GOAL: Help users easily maximize performance on TI platforms while minimizing development cost.

Performance

Graph-based model

Defined at initialization time for optimal run time and latency

True Heterogeneous Compute

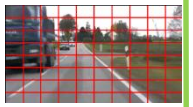
Abstracted access to heterogeneous cores

Optimized Libraries

Fully optimized OpenVX 1.1 kernels

DMA Integration

DMA interface for tiled access



Virtual Buffers

Intermediate buffers in internal memories

Software Abstraction

Application works across SW platforms from Linux to TI-RTOS

Open Standard

Conformant to **OpenVX v1.1**

Hardware Abstraction

Application works across TDA family of SoCs

Ease of use

PC based development environment

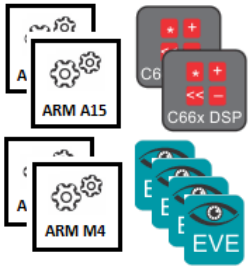
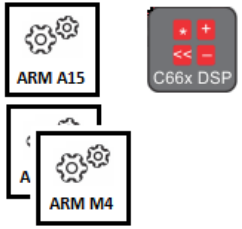
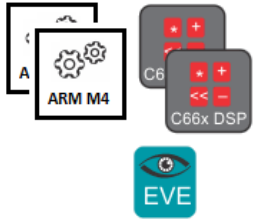
PyTIOVX tool for graph description

generates OpenVX Application code

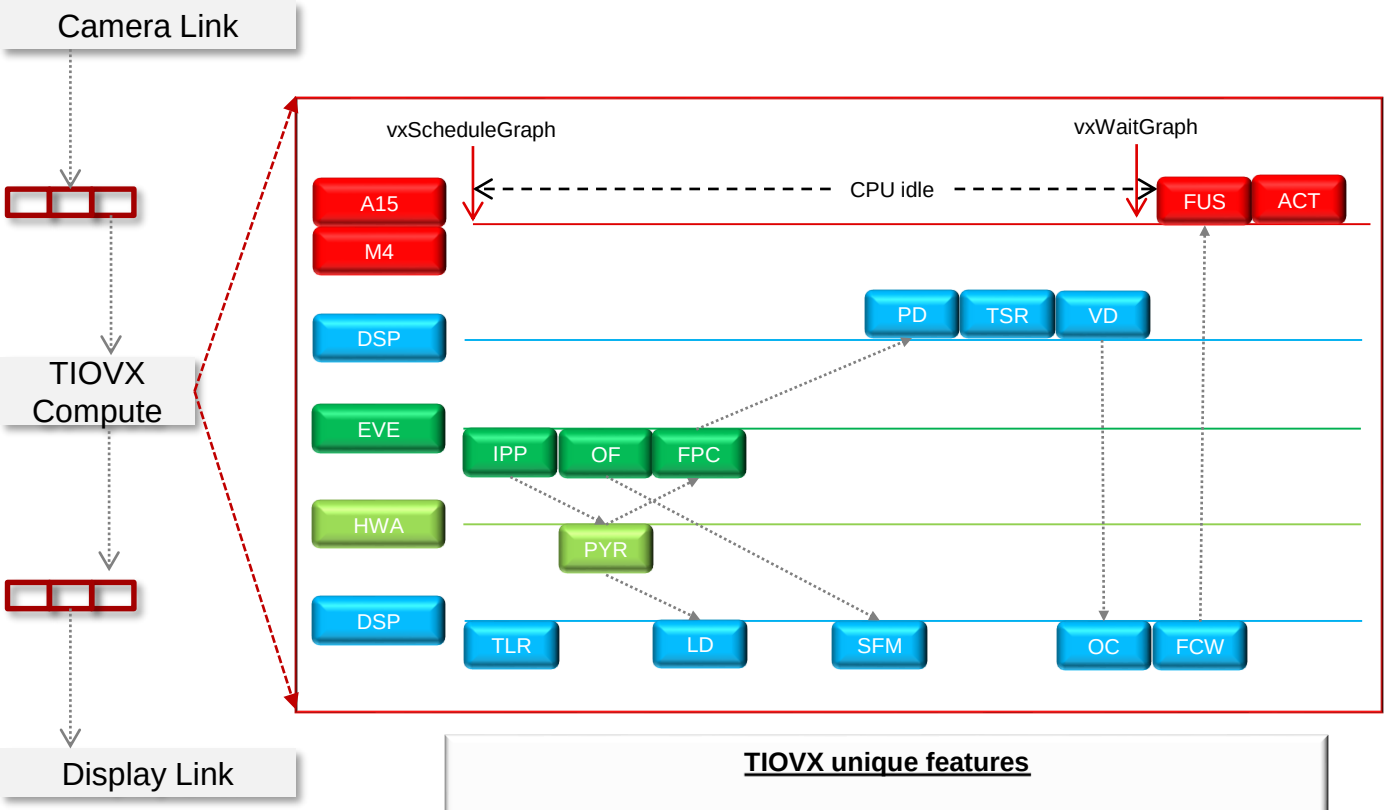
Development Cost

Result: Full entitlement on TI SoCs through performance portable OpenVX interface

TIOVX supports scalable TDA SOC family for ADAS (Open VX1.1)

	TDA2x	TDA2Eco	TDA3x
SOCs			
OpenVX Cores			
OS	TI-RTOS Linux	TI-RTOS Linux	TI-RTOS
ADAS applications			

Distributed TIOVX graph for front camera analytics



Abbreviations

FUS	Sensor Fusion
ACT	Actuation
PD	Pedestrian Detect
TSR	Traffic Sign Recognition
VD	Vehicle Detect
IPP	Image Pre-Processing
OF	Optical Flow
FPC	Feature Plane Compute
PYR	Image Pyramid
TLR	Traffic Light Recognition
LD	Lane Detect
SFM	Structure From Motion
OC	Object Classification
FCW	Forward Collision Warning

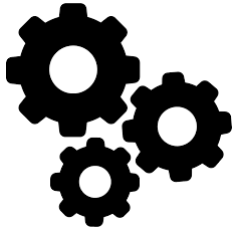
TIOVX unique features

Distributed execution for better utilization
Camera/Display pipelining outside Open VX using TI SDK
Data IO acceleration and tiling support through DMA and virtual buffers

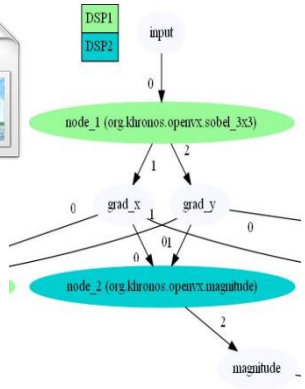
Open VX data objects

PyTIOVX - Automated OpenVX "C" Code Generation

```
'''
from tiovx import *

context = Context("vx_tutorial_
graph = Graph()

width = 640
height = 480

in_image = Image(width, height,
grad_x = Image(width, height, D
grad_y = Image(width, height, D
magnitude = Image(width, height
phase = Image(width, height, Df
grad_x_img = Image(width, heigh
grad_y_img = Image(width, heigh
magnitude_img = Image(width, he
shift = Scalar(Type.INT32, 0, n

graph.add ( NodeSobel3x3(in_ima
graph.add ( NodeMagnitude(grad_
graph.add ( NodePhase(grad_x, g
graph.add ( NodeConvertDepth(ma
graph.add ( NodeConvertDepth(gr
graph.add ( NodeConvertDepth(gr

context.add ( graph )

ExportImage(context).export()
ExportCode(context).export()
```



PyTIOVX




```
if (status == VX_SUCCESS)
{
    usecase->input = vxCreateImage(context, 640, 480, VX_DF_IMAGE_U8);
    if (usecase->input == NULL)
    {
        status = VX_ERROR_NO_RESOURCES;
    }
    vxSetReferenceName( (vx_reference)usecase->input, "input");
}
if (status == VX_SUCCESS)
{
    usecase->grad_x = vxCreateImage(context, 640, 480, VX_DF_IMAGE_S16)
    if (usecase->grad_x == NULL)
```

- Generated C code can run on SoC without modifications
- Visualize graph connections
- Trap and fix common mistakes before executing on target SoC

Summary

- TI's OpenVX 1.1 implementation supports true multi-core heterogeneous compute using ARM, DSP, EVE and HWAs on TDAx family of SoCs
- Distributed graph execution, DMA acceleration using BAM and pipelined camera/display with TI SDK – Vision helps achieve high performance, high core utilization, low latency and low CPU overheads
- Hardware abstractions allow OpenVX implementation to run on "Big ARM" CPUs with Linux as well as "MCU ARM" CPUs using TI-RTOS
- Ease of use via PyTIOVX tool, PC emulation mode help developers quickly ramp-up to use OpenVX on TI SoCs

TIOVX for OpenVX 1.1 will be available at www.ti.com/adas soon