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EMBEDDED
COMPUTING
MADE EASY

Product Brief
Aquila AM69

External Content
Last updated: November 27, 2024

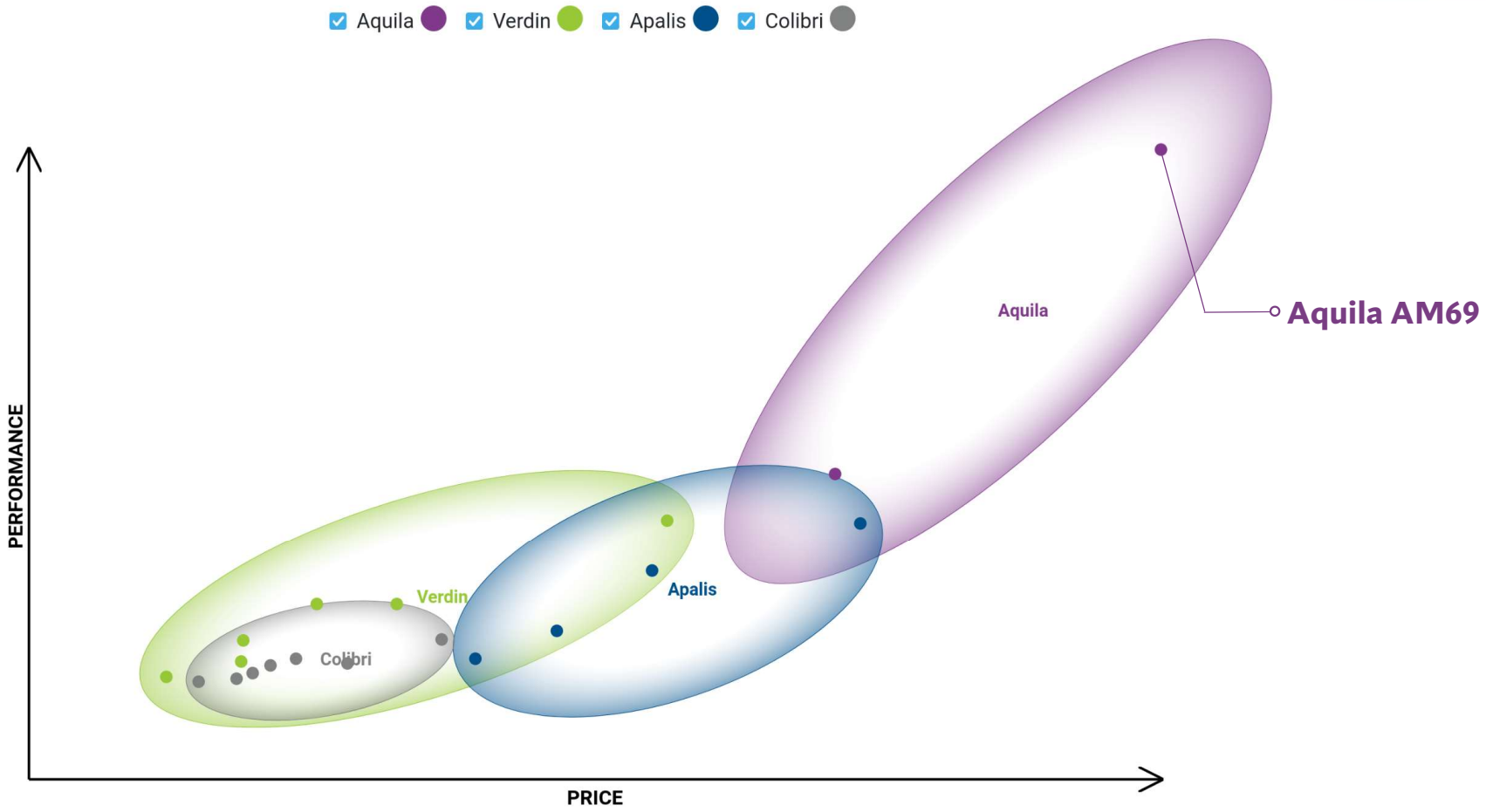
Highlights

- Toradex's highest-performing SoM
- Based on the TI AM69 processor with up to 8x ARM Cortex-A72 cores
- State-of-the-art Deep Learning Accelerator with up to 32 TOPS
- Ideal for AI, computer vision applications, real-time control, edge processing and smart gateways
- Rich industrial interfaces on a 400 pins board-to-board connector
- LTS-supported Linux Software stack, including OTA, Remote Access, and Device Monitoring

A72 A72 A72 A72
A72 A72 A72 A72 2.0GHz
R5F R5F 1.0GHz
32 TOPS NPU
3D GPU
DMPAC
2x ISP
32GB RAM
128GB FLASH

https://www.toradex.com/computer-on-modules/aquila-arm-family/ti-am69

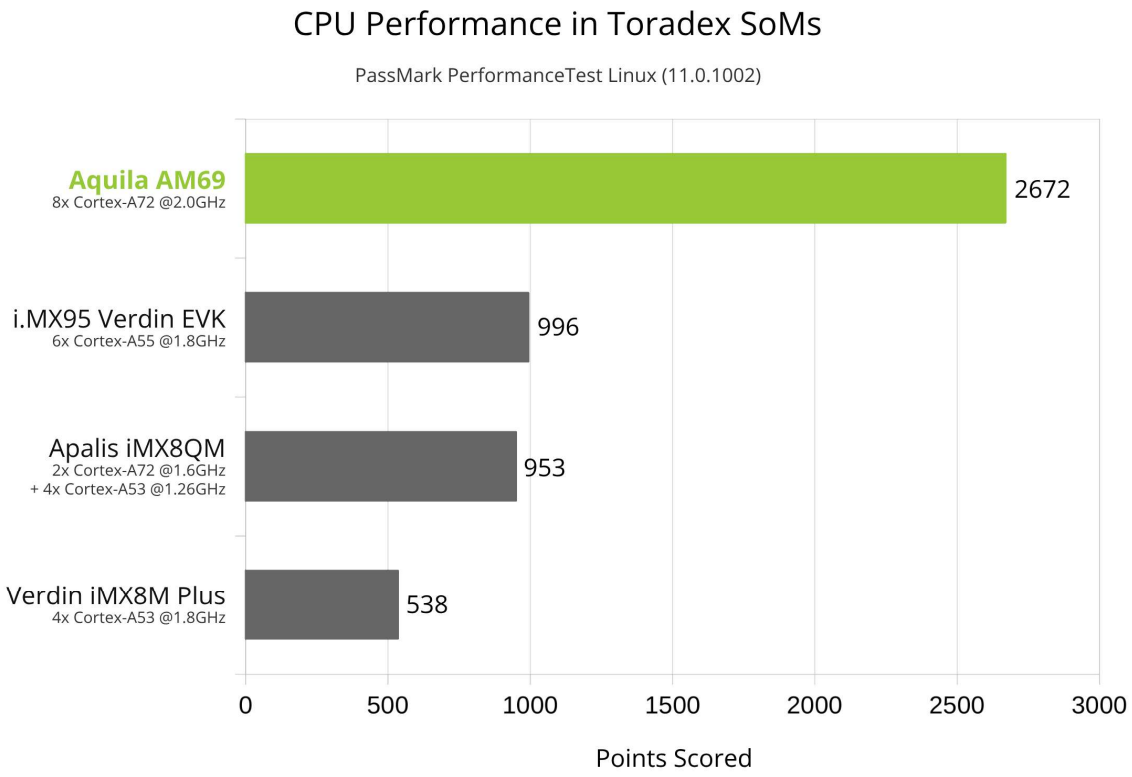
Aquila AM69 Positioning

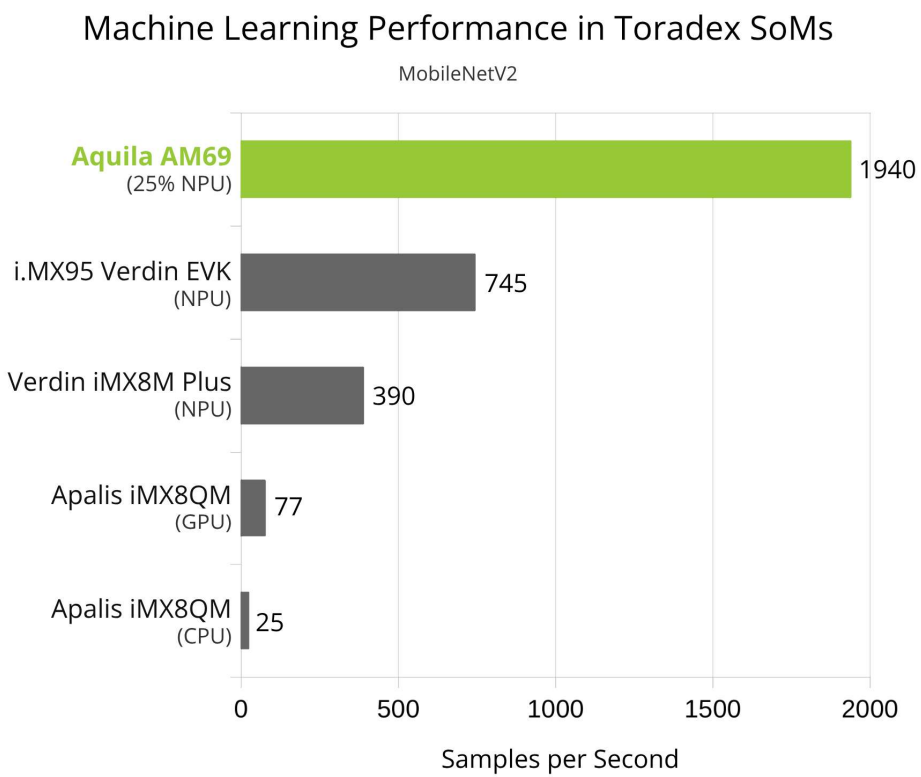


https://www.toradex.com/computer-on-modules#product-performance

High Performing System-on-Module

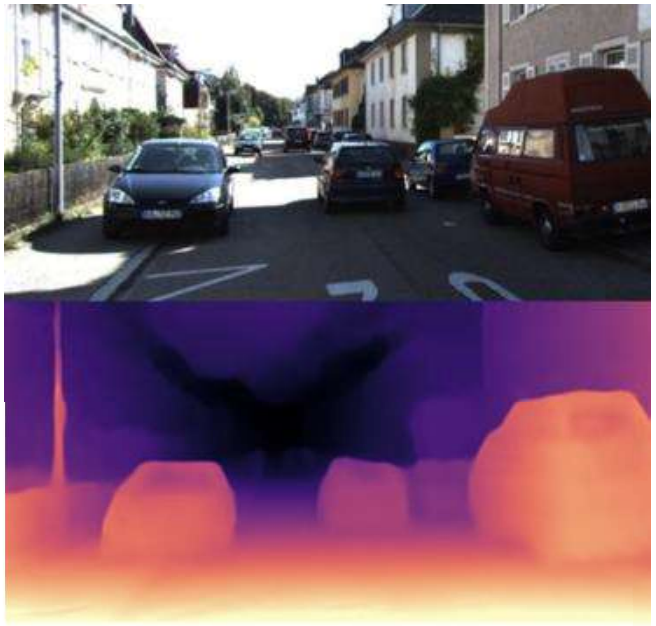
- High CPU Performance
- High Machine Learning Performance

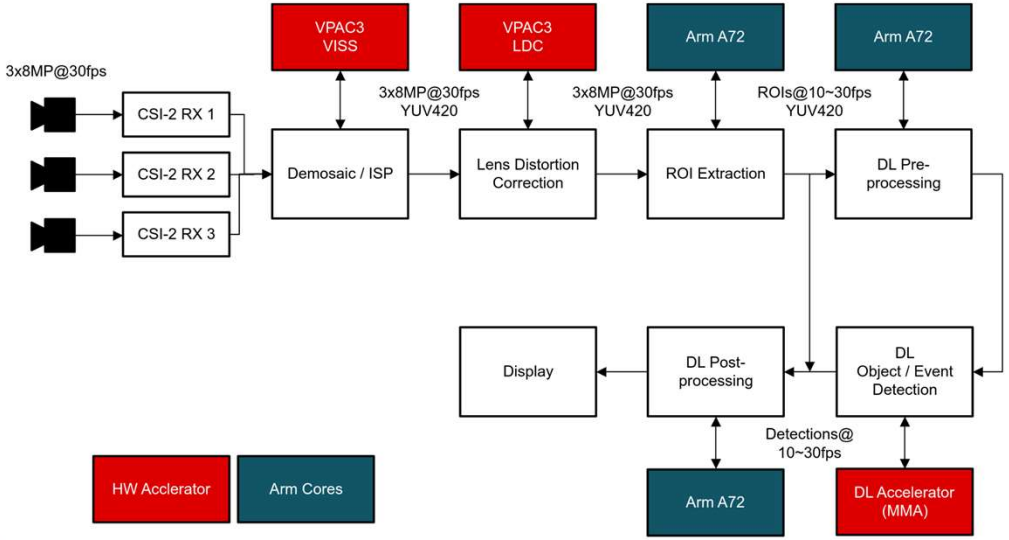




High Throughput Video Processing

- 3x 4-Lane MIPI CSI-2 ports, allows for example:
  - 3x 4K cameras @ 60 fps
  - 12x 1080p cameras @ 60 fps
- 2x Vision Processing Accelerators: de-noise images, downscale, ...
- Stereo Video Processing (DMPAC): calculate depth maps in accelerated hardware, and apply it to distance measuring, collision warning, path planning, and other algorithms.





Machine Vision Block Diagram With Data Flow on AM69A

AM69A Resource Utilization and Power Consumption Estimate for the Machine Vision Use Case

Main IP	Utilization (3 × 8MP at 30 fps)
3 × CSI-2 RX	3 × 8MP at 30 fps = 11.52 Gbps (38%)
VPAC (VISS, LDC)	3 × 8MP at 30 fps = 720 MP/s (60%)
MMA	24 TOPS (75%)
8 × A72	ROI extraction, DL pre- and post-processing, and so forth (50%)
DSS	100%
DDR Bandwidth	15.35GBps (24%)
Power Consumption (85°C)	19 W

8 Video Streams Demo

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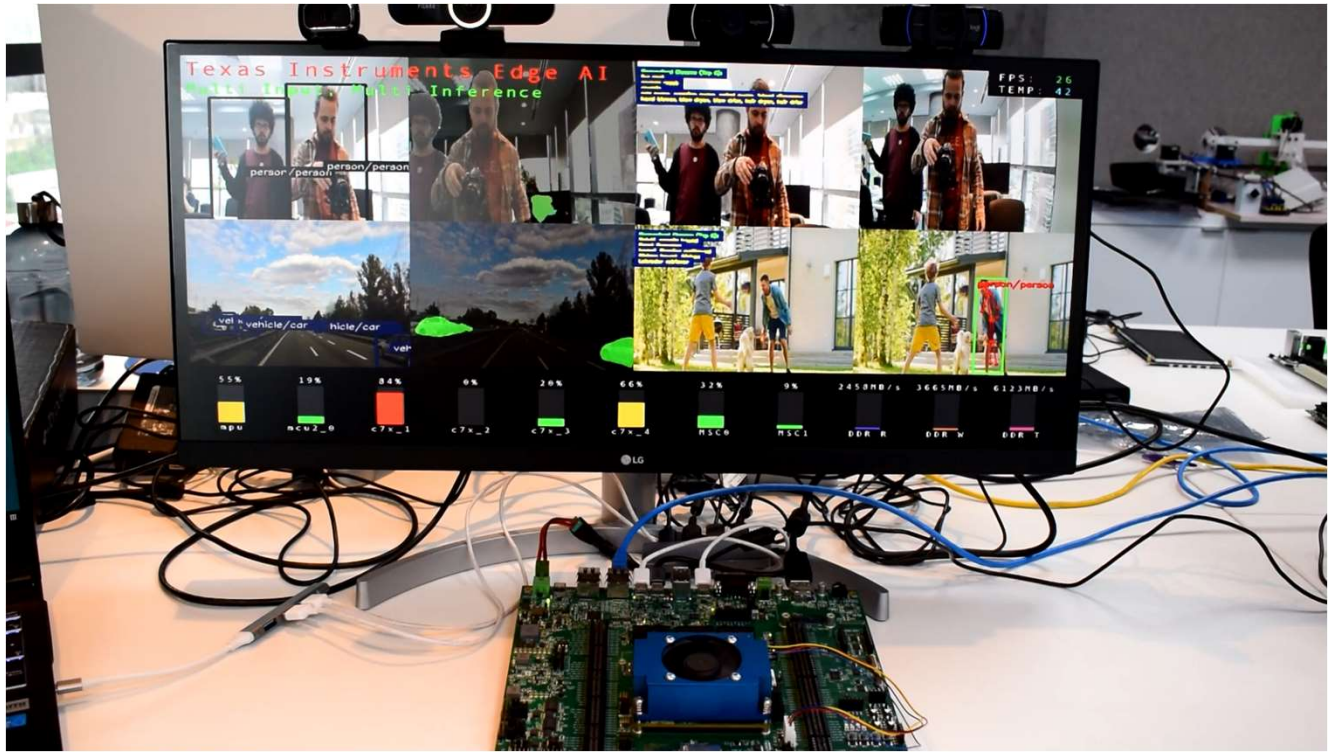
- Eight different ML models in parallel, at a stable 30 fps
- Parallel Video Encoding @1080p 30fps
  - 4 from webcams
  - 4 from video files
- Stable working temperature: 40°C
- Power Consumption: 30 W
- Easy to try. Multiple models available:

```
ONR-CL-6360-regNetx-200mf
ONR-KD-7060-human-pose-yolox-s-640x640
ONR-OD-8020-ssd-lite-mobv2-mmdet-coco-512x512
ONR-OD-8200-yolox-nano-lite-mmdet-coco-416x416
ONR-OD-8220-yolox-s-lite-mmdet-coco-640x640
ONR-OD-8270-yolox-pico-lite-mmdet-coco-320x320
ONR-OD-8410-yolox-tiny-lite-mmdet-widerface-416x416
ONR-OD-8420-yolox-s-lite-mmdet-widerface-640x640
ONR-SS-7618-deeplabv3lite-mobv2-qat-robokit-768x432
ONR-SS-8610-deeplabv3lite-mobv2-ade20k32-512x512
TFL-CL-0000-mobileNetV1-mlperf
TFL-OD-2020-ssdLite-mobDet-DSP-coco-320x320
TFL-SS-2580-deeplabv3_mobv2-ade20k32-mlperf-512x512
TVM-CL-3090-mobileNetV2-tv
TVM-OD-5120-ssdLite-mobDet-DSP-coco-320x320
TVM-SS-5710-deeplabv3lite-mobv2-cocoseg21-512x512
```



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Deep Learning Ecosystem – Edge AI

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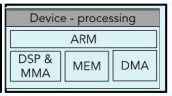
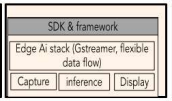
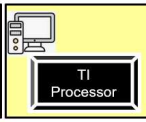
TI offers a Deep Learning software ecosystem with a great developer experience. ML developers can easily:

- Evaluate and tune a wide range of models
- Compile and optimize their own models for the AM69
- Run accelerated inference on the device
- and more...

Category		Tools/software	
Model Training & associated tools		**Model optimization tools (training env)** (Quantization aware training, sparsity, model surgery)	**Model zoo, Model training** (Object Detection, Human Pose estimation, 6D pose estimation, Depth, 3D OD,..)
Inference Tools		**Model compilation tools** Model import, Post training Quantization, Network Compiler	
Inference Runtime		**Model inference software** TFLite-RT, ONNX-RT, NEO AI DLR, TIDL-RT	
Edge AI SDK		**Edge AI SDK** End-to-end AI pipeline with camera, inference and display	
Integrated Environment		**Model Maker, Edge AI Studio : Model Composer, Model Analyzer**	

Bring Your Own Model (BYOM) Workflow

To do **first level check** of model if it can run on TI device or not and what latency it can achieve

If user doesn't have hardware and want to get latency measurement, **Model Analyzer** service can be used

edgeai-tidl-tools or Model Analyzer

Bring Your Own Model (BYOM) → Compile → Validate (file IO) (TI Processor)

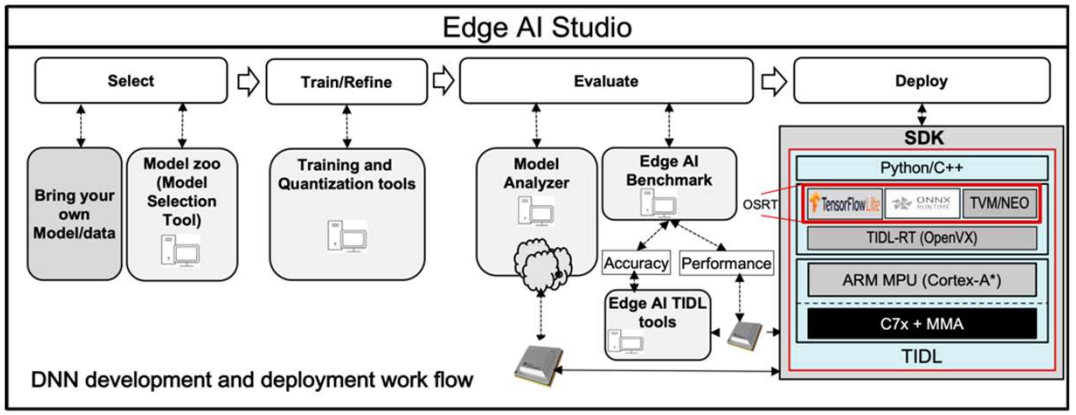
To perform exhaustive accuracy benchmark or deployment to TI development board after first level check

edgeai-benchmark

Bring Your Own Model (BYOM) → Accuracy benchmark (file IO) (TI Processor)

Edge AI SDK

Deployment with real time sensors (TI Processor)



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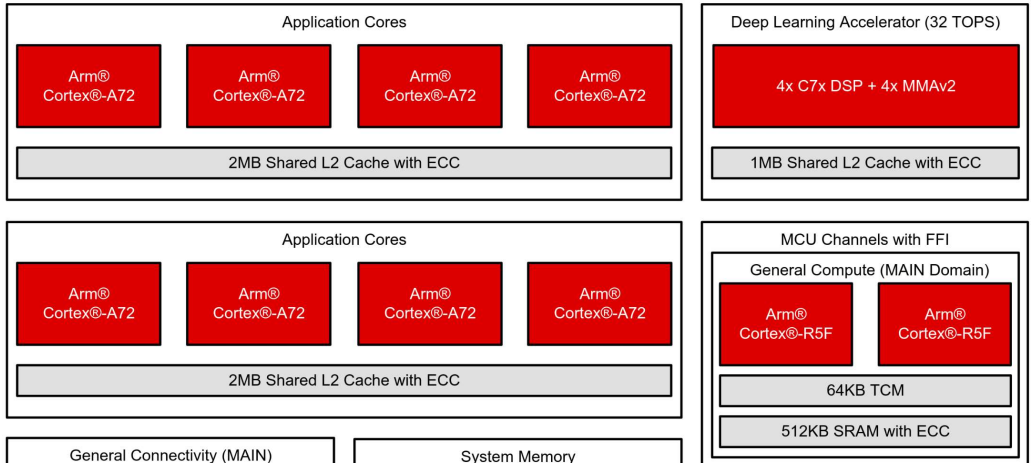
Real-Time Processing and Control

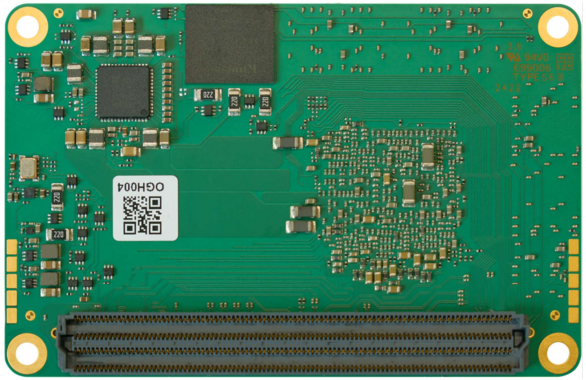
- The AM69 features 2x Cortex-R5F
- Faster and safer than the usual Cortex-M
- 1000 MHz (R5) vs. <800 MHz (Cortex-M)
- Split/Lockstep Operation, ECC
- Makes the Aquila AM69 perfect for Industrial Control, and real-time applications

Feature	Cortex-R	Cortex-M
Focus	Real-time, safety critical applications	Cost-sensitive, low-power applications
Performance	High	Medium
Safety Features	Extensive	Limited
Power Consumption	Medium	Low
Applications	Automotive, Industrial, Medical, Militar	Edge IoT, Consumer, Non-Critical Systems



Extensive Interface Set

400 pins board-to-board connector exposes a great number of interfaces to the Carrier Board



Highlights

- 6x Ethernet with TSN
- 3x PCIe ports
- 3x Quad-Lane MIPI CSI-2 (up to 12x FHD cameras)
- 19x CAN FD
- 3x Display Interfaces (up to 4K)

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Connectivity	
USB 3.2	1x DRD (Gen 1) 1x Host (Gen 1)
Ethernet	1x Gigabit with TSN
xGMII (for additional Ethernet)	4x 2.5 Gigabit with TSN 1x 10 Gigabit with TSN
Wi-Fi	2.4/5/6 GHz Tri-band 2x2 Wi-Fi 7 (802.11be)
Bluetooth	Bluetooth Classic / BLE 5.3
PCIe	2x (x2 Gen 3) 1x (x1 Gen 3)
I2C	8x
SPI	7x
QSPI	1x
UART	11x
PWM	12x
Analog Input	8x
SDIO/SD/MMC	1x
CAN FD	19x
GPIO	110x
JTAG	1x

Multimedia	
Neural Processing Unit (NPU)	32 TOPS
Image Signal Processor (ISP)	2x
Depth And Motion Processing Accelerator (DMPAC)	Yes
Display Controller	Triple
2D Acceleration	Yes
3D Acceleration	Yes
Video Decoder	H.264/AVC and H.265/ HEVC
Video Encoder	H.264/AVC and H.265/ HEVC
Display Serial Interface	2x Quad Lane MIPI DSI
Display Port	1x (up to 4k)
Digital Audio	5x McASP: I2S or TDM
Camera Serial Interface	3x Quad Lane MIPI CSI-2

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Best Player in The Market (vs. x86)

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Aquila AM69 is a better fit for:

- Machine Learning and AI applications
- Applications requiring Real-Time/Safety

Aquila AM69 and Atom x6400 are comparable for:

- Industrial PCs and general computing applications

intel

	Aquila AM69	x86 (e.g. Atom x6400)
AI Performance	Deep Learning Accelerator (32 TOPS)	No Acceleration
Real-Time Cores	2x Cortex R5F	N/A
Built-in Connectivity	Wi-Fi and Bluetooth	Usually N/A
CPU Performance (PassMark)	2672	2990
Power Consumption (TDP)	25 W	25 W
Cost at similar configurations	~$500 (high-end)	~$500 (high-end)

Best Player in The Market (vs. NVIDIA)

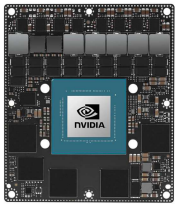
Aquila AM69 is a better fit for:

- Industrial and other harsh environments

Note: For similar industrial features, NVIDIA gets very expensive

Aquila AM69 and the Jetson Orin NX are comparable for:

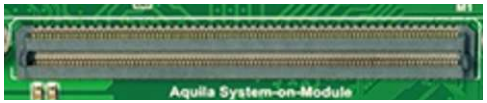
- Typical ML/AI applications with no industrial requirements

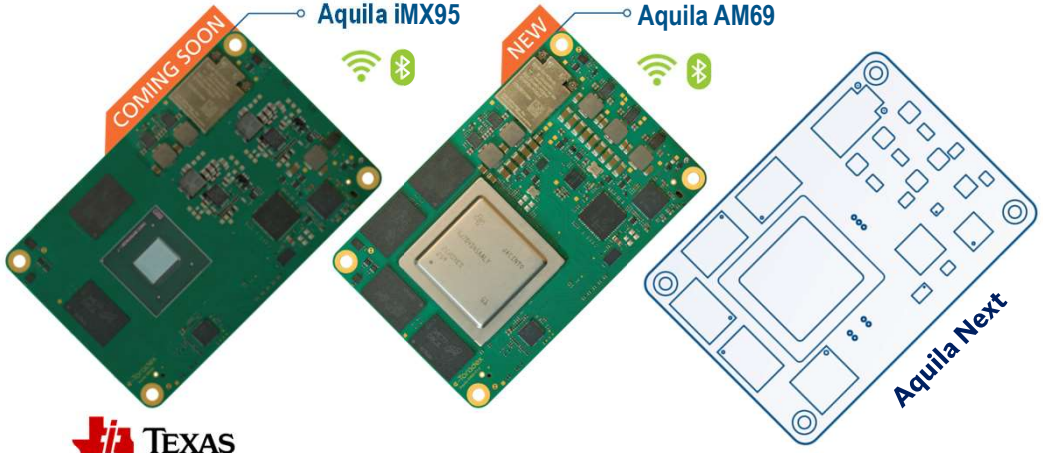


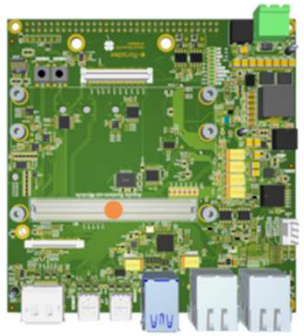
	Aquila AM69	Jetson Orin NX	Jetson Orin AGX Industrial
Industrial Grade	Yes	No	Yes
Temperature Range	-40 to 85°C	-25 to 80°C	-40 to 85°C
Operating Lifetime	10 years @85° C	5 years	10 years @85° C
Cost	~$500	~$600	~$2150
Real-Time Cores	2x Cortex R5F	No	No
Built-in Connectivity	Wi-Fi and Bluetooth	N/A	N/A
Power Consumption (TDP)	25 W	25 W	75 W

Aquila Family Ecosystem

- Performance Scalability: from i.MX95 to AM69 and beyond
- Thermal Solution (heatsink + heat spreader + built-in fan)
- Aquila Development Board
- Camera (OV5640) for evaluating and integrating Machine Vision applications
- **(coming soon)** Clover: Production-Ready, Volume Carrier Board
- **(coming soon)** Mating Board-to-Board Connector







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