

# Cameras readout scheme: technologies survey and initial proposal

Herman Pessoa Lima Júnior  
Tiago Antônio Borba Oliveira

# Comparative analysis between frame grabbers

- Kaya Instruments - Komodo KY-FGK-801
  - 8 channels
  - Control by DMA (Physical address support (GPU transfers)); FPGA
  - Approximate cost: U\$ 1650,00
  - Approximate cost/channel: U\$ 206,25
  - When questioned by prof. Rafael, regarding the flexibility in customizing algorithms for building a trigger structure based on image processing, the answer was obtained:
    - Unable to load user logic into the FPGA of this model



- Euresys - CoaxLink Octo
  - 8 channels
  - Control by GPU Direct
  - Approximate cost: U\$ 2599,00
  - Approximate cost/channel: U\$ 324,88
  - DMA support for AMD DirectGMA and NVidia (Cuda)



## COMPARISON - BEST MODELS

Model	Cost	Cost/channel	DMA	Connectors (camera)	Interface (camera)	Number of channels	Number of lines	Interface FG
<b>KY-FGK-801 (Kaya)</b>	US\$1.650,00	US\$206,25	GPU-Direct/ DirectGM A	DIN1.0/2.3 CXP-6	CoaXPress 1.0 and 1.1	8	40 I/O lines: •4 differential inputs•4 differential outputs•8 singled-ended TTL inputs/outputs•8 singled-ended LVTTTL inputs/outputs•8 opto-isolated inputs•8 opto-isolated outputs	PCI Express 3.0
<b>CoaxLink Octo (Euresys)</b>	US\$2.599,00	US\$324,88	GPU-Direct/ DirectGM A	DIN1.0/2.3 CXP-6	CoaXPress 1.0, 1.1 and 1.1.1	8	10 I/O lines on INTERNAL I/O connector: • 2 differential inputs (DIN) • 2 singled-ended TTL inputs/outputs (TTLIO) • 4 isolated inputs (IIN) • 2 isolated outputs (IOUT) •NOTE: The number of I/O lines can be extended using I/O modules attached to the I/O EXTENSION connector.	PCI Express 3.0

	<b>KY-FGK-801 (Kaya)</b>	<b>CoaxLink Octo (Euresys)</b>
Delivery/bus bandwidth	6,710 MB/s	6,700 MB/s
Resolution	High	High
Maximum aggregated camera data transfer rate	50Gbit/s	50Gbit/s
Maximum stream packet size	8,192 bytes	16,384 bytes

**Observation:** The maximum stream packet size it is related to the camera's frame rate, so the manufacturer's calculator should check the exact influence of this value on the frame rate.

- As for the difference in the maximum stream packet size, Kaya ensured that for the intended application, the frame grabber serves very well, even with a lower value than the competitor's.
- The Kaya and Euresys frame grabber are quite similar in specifications.
- The Kaya frame grabber seems to be more interesting compared to the Euresys model due to: it has 40 I/O lines (against 10 I/O lines of Euresys), it is cheaper.

# Comparative analysis between Servers



# Comparison between servers

COMPARATIVE ANALYSIS BETWEEN SERVERS

Manufacturer	Model	Supported processor	RAM Memory	Slots PCIe 3.0 (x16)	GPU-Optimized	Value	Link to product
GPX	XT8-22S1-16GPU	Intel Xeon (Scalable)	3TB	16	Yes	US\$7.089,00	<a href="https://www.thinkmate.com/system/gpx-xt8-22s1-16gpu">https://www.thinkmate.com/system/gpx-xt8-22s1-16gpu</a>
SUPERMICRO	SYS-2028GR-TRHT	Intel® Xeon® processor E5-2600 v4/ v3 family	2TB	6	Yes	US\$3.942,00	<a href="https://www.thinkmate.com/system/superserver-2028gr-trht">https://www.thinkmate.com/system/superserver-2028gr-trht</a>
TYAN	Thunder HX FT77D-B7109	Intel Xeon (Scalable)	3TB	9	Yes	US\$6.447,00	<a href="https://www.thinkmate.com/system/tyan-ft77db7109-(b7109f77dv4hr-2t-nfz)">https://www.thinkmate.com/system/tyan-ft77db7109-(b7109f77dv4hr-2t-nfz)</a>
GIGABYTE	G291-2G0	Intel Xeon (Scalable)	3TB	16	Yes	US\$7.038,00	<a href="https://www.thinkmate.com/system/gigabyte-g291-2g0">https://www.thinkmate.com/system/gigabyte-g291-2g0</a>
GIGABYTE	G291-280	Intel Xeon (Scalable)	3TB	8	Yes	US\$5.388,00	<a href="https://www.thinkmate.com/system/gigabyte-g291-280">https://www.thinkmate.com/system/gigabyte-g291-280</a>

- The Gigabyte (model G291-2G0) and Tyan models were discarded because they have PCIe slots beyond the necessary and they are much more expensive.
- The **Supermicro** model seems to be interesting for the project given the low investment cost (compared to other servers), the number of PCIe slots are sufficient for the initial demands of the project.
- The only specification that differs between the Supermicro models and the Gigabyte model (G291-280) is the maximum amount of RAM supported, where the Supermicro model is inferior, but still within the design parameters.
- For the initial proposal, projects using both defined models will be considered.

# Comparative analysis between GPUs

# Comparison between models



NVIDIA Quadro P5000 -  
Graphics card - Quadro P5000  
- 16 GB GDDR5 - PCIe 3.0 x16 -  
DVI, 4 x DisplayPort

☆☆☆☆☆ 0.0 (0)

Manufacturer part VCQP5000-PB  
Dell part A9304914

List Price	€1,975.00
Shipping	Free
<b>Dell Price</b>	<b>\$1,775.00</b>



PNY NVIDIA Quadro RTX 6000  
Graphics Card 24 GB GDDR6  
PCIe 3.0 x16 4 x DisplayPort,  
USB-C

★★★★★ 5.0 (1)

Manufacturer part VCQRTX6000-SB  
Dell part AA413562

List Price	€4,378.99
Shipping	Free
<b>Dell Price</b>	<b>\$3,999.99</b>



PNY NVIDIA Quadro RTX 5000  
Graphics Card 16 GB GDDR6  
PCIe 3.0 x16 4 x DisplayPort,  
USB-C

★☆☆☆☆ 1.0 (1)

Manufacturer part VCQRTX5000-SB  
Dell part AA413561

List Price	€2,407.99
Shipping	Free
<b>Dell Price</b>	<b>\$2,199.99</b>



PNY PART NUMBER	VCQP5000-PB
<b>SPECIFICATIONS</b>	
GPU Memory	16 GB GDDR5X
Memory Interface	256-bit
Memory Bandwidth	Up to 288 GB/s
NVIDIA CUDA® Cores	2560
System Interface	PCI Express 3.0 x16
Max Power Consumption	180 W
Thermal Solution	Active
Form Factor	4.4" H x 10.5" L, Dual Slot, Full Height
Display Connectors	4x DP 1.4 + DVI-D DL
Max Simultaneous Displays	4 direct, 4 DP 1.4 Multi-Stream
Max DP 1.4 Resolution	7680x4320 @ 30 Hz
Max DVI-D DL Resolution	2560x1600 @ 60 Hz
Graphics APIs	Shader Model 5.1, OpenGL 4.5 <sup>4</sup> , DirectX 12.0 <sup>5</sup> , Vulkan 1.0 <sup>6</sup>
Compute APIs	CUDA, DirectCompute, OpenCL™



PNY PART NUMBER	VCQRTX6000-PB
<b>SPECIFICATIONS</b>	
GPU Memory	24 GB GDDR6
Memory Interface	384-bit
Memory Bandwidth	Up to 672 GB/s
ECC	Yes
NVIDIA CUDA Cores	4,608
NVIDIA Tensor Cores	576
NVIDIA RT Cores	72
Single-Precision Performance	16.3 TFLOPS
Tensor Performance	130.5 TFLOPS
NVIDIA NVLink	Connects 2 Quadro RTX 6000 GPUs <sup>1</sup>
NVIDIA NVLink bandwidth	100 GB/s (bidirectional)
System Interface	PCI Express 3.0 x 16
Power Consumption	Total board power: 295 W Total graphics power: 260 W
Thermal Solution	Active
Form Factor	4.4" H x 10.5" L, Dual Slot, Full Height
Display Connectors	4xDP 1.4, 1x USB-C
Max Simultaneous Displays	4x 4096x2160 @ 120 Hz, 4x 5120x2880 @ 60 Hz, 2x 7680x4320 @ 60 Hz
Encode / Decode Engines	1X Encode, 1X Decode
VR Ready	Yes
Graphics APIs	DirectX 12.0 <sup>5</sup> , Shader Model 5.1 <sup>1</sup> , OpenGL 4.5 <sup>4</sup> , Vulkan 1.0 <sup>6</sup>
Compute APIs	CUDA, DirectCompute, OpenCL™

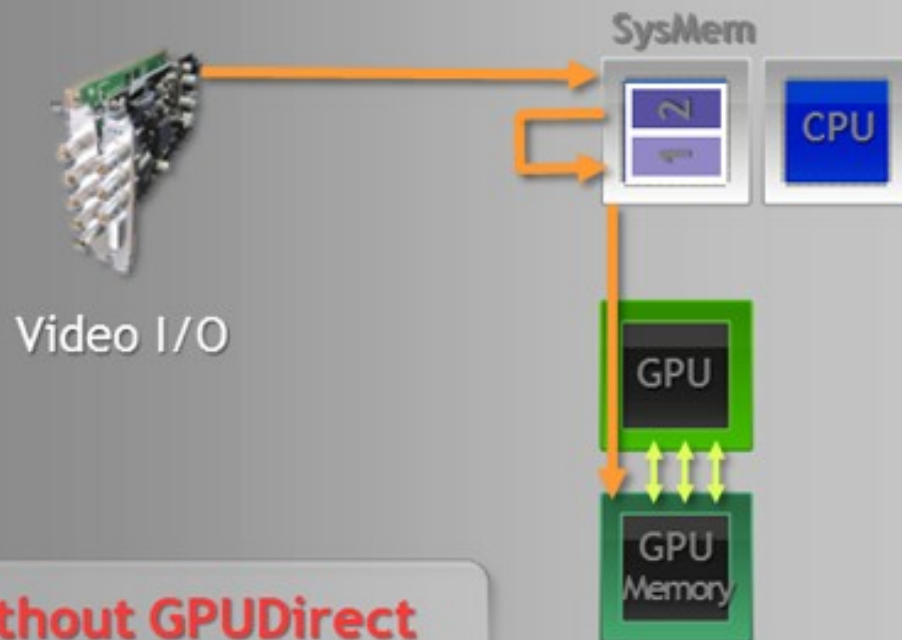


PNY PART NUMBER	VCQRTX5000-PB
<b>SPECIFICATIONS</b>	
GPU Memory	16 GB GDDR6
Memory Interface	256-bit
Memory Bandwidth	Up to 448 GB/s
ECC	Yes
NVIDIA CUDA Cores	3,072
NVIDIA Tensor Cores	384
NVIDIA RT Cores	48
Single-Precision Performance	11.2 TFLOPS
Tensor Performance	89.2 TFLOPS
NVIDIA NVLink	Connects 2 Quadro RTX 5000 GPUs <sup>1</sup>
NVIDIA NVLink bandwidth	50 GB/s (bidirectional)
System Interface	PCI Express 3.0 x 16
Power Consumption	Total board power: 265 W Total graphics power: 230 W
Thermal Solution	Active
Form Factor	4.4" H x 10.5" L, Dual Slot, Full Height
Display Connectors	4xDP 1.4, 1x USB-C
Max Simultaneous Displays	4x 4096x2160 @ 120 Hz, 4x 5120x2880 @ 60 Hz, 2x 7680x4320 @ 60 Hz
Encode / Decode Engines	1X Encode, 2X Decode
VR Ready	Yes
Graphics APIs	DirectX 12.0 <sup>5</sup> , Shader Model 5.1 <sup>1</sup> , OpenGL 4.5 <sup>4</sup> , Vulkan 1.0 <sup>6</sup>
Compute APIs	CUDA, DirectCompute, OpenCL™

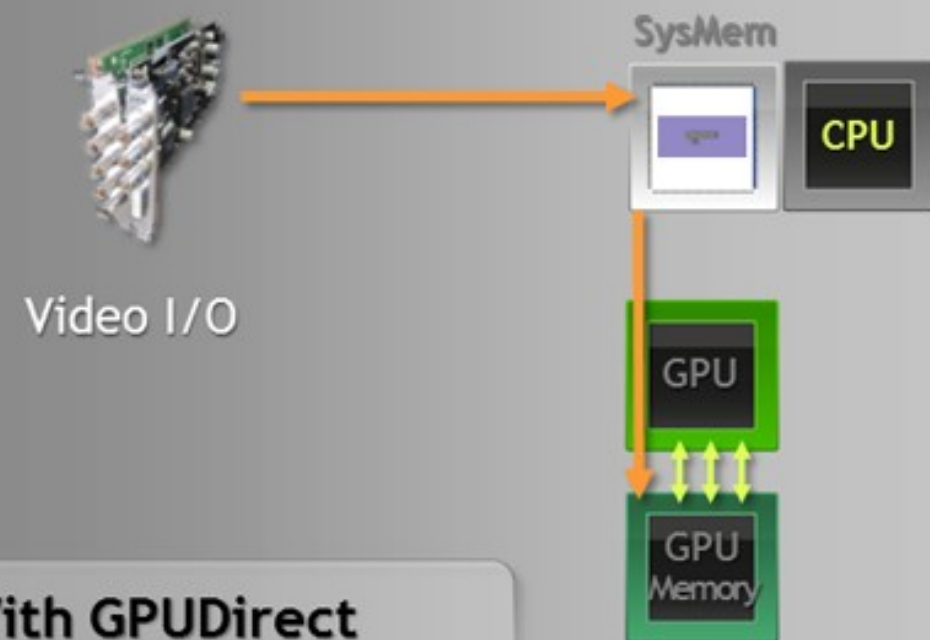
- Due to the higher compatibility reported by the manufacturers of servers and frame grabbers, we decided to survey only the Nvidia GPUs.
- The main prerequisite for analyzing GPU models was support for GPUDirect.
- Comparing the models both have characteristics that, initially, should be enough for the project. Therefore, the decision factor could be the initial cost.
- The **RTX5000 model** is the one with the best cost-benefit ratio in relation to the others.

# Cameras Readout proposal

- CPU Manages Data Transfers Between Devices
- No Synchronization Between Devices
- Smallest Transfer Size is a Field

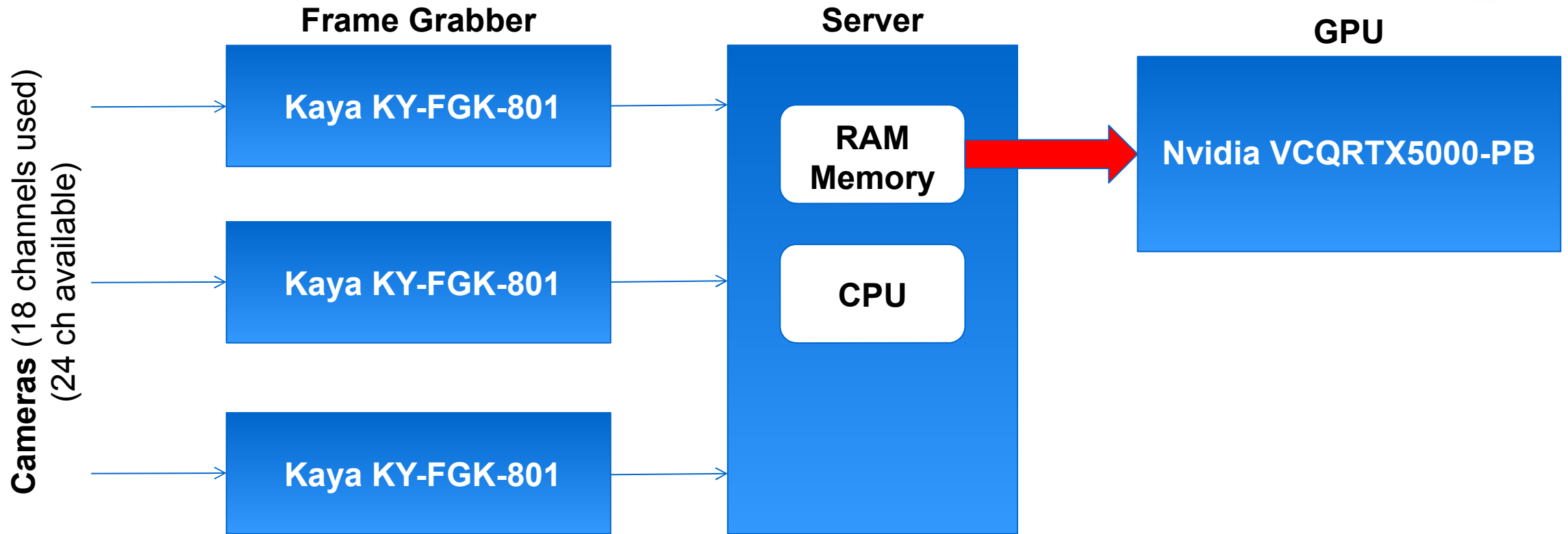


- CPU overhead is Minimized
- Transfers are Synchronized
- Smallest Transfer Size Smaller than a Field





# Cameras readout scheme - Initial Proposal



The server model:  
SYS-2028GR-TRHT (Supermicro) or  
G291-280 (Gigabyte)

- Considering 3 Frame Grabbers (24 channels) + GPU + Server:
  - ✓ **US\$ 11.091,99** (with Supermicro server)
  - ✓ US\$ 12.537,99 (with Gigabyte server)