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ESRF | The European Synchrotron

High throughput DAQ for X-RAY DETECTORS

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AGENDA

- Introduction
- DAQ framework Concept
- Implementation
- Advanced prototype
- Experimental results
- Conclusions and future work

INTRODUCTION

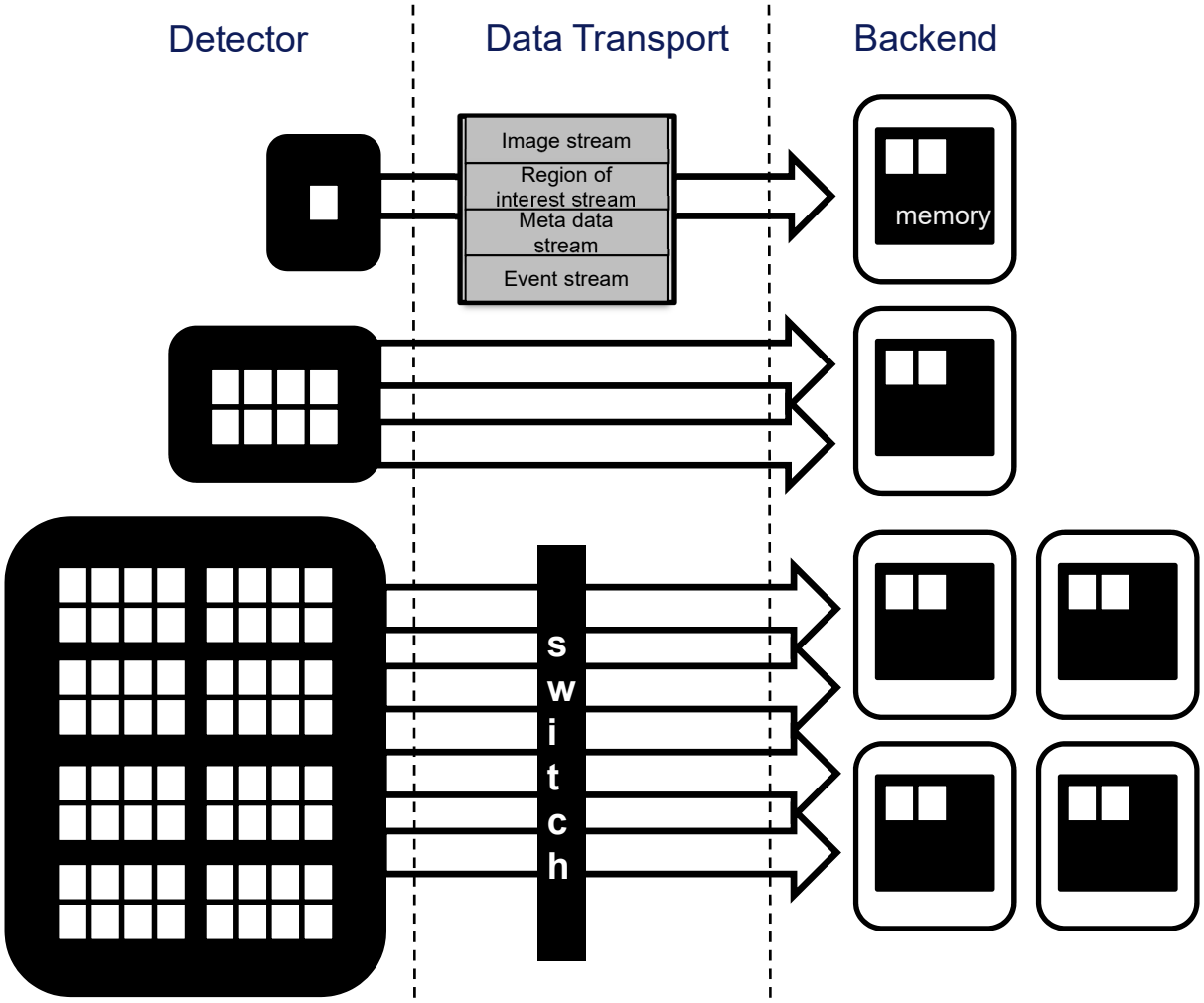
Motivations:

- Current and upcoming advanced detectors produce data throughput in 1-100 GB/s range
- Industrial DAQ protocols do not handle the required data throughput
- The need for a standard tool
- Reusable in a wide range of detectors

Objectives:

- RASHPA: RDMA-based Acquisition System for High Performance Applications
- Initiated in the frame of the European Project: CRISP
- Sufficiently generic and scalable
- Suitable for diversity of new high performance detectors

RASHPA CONCEPT

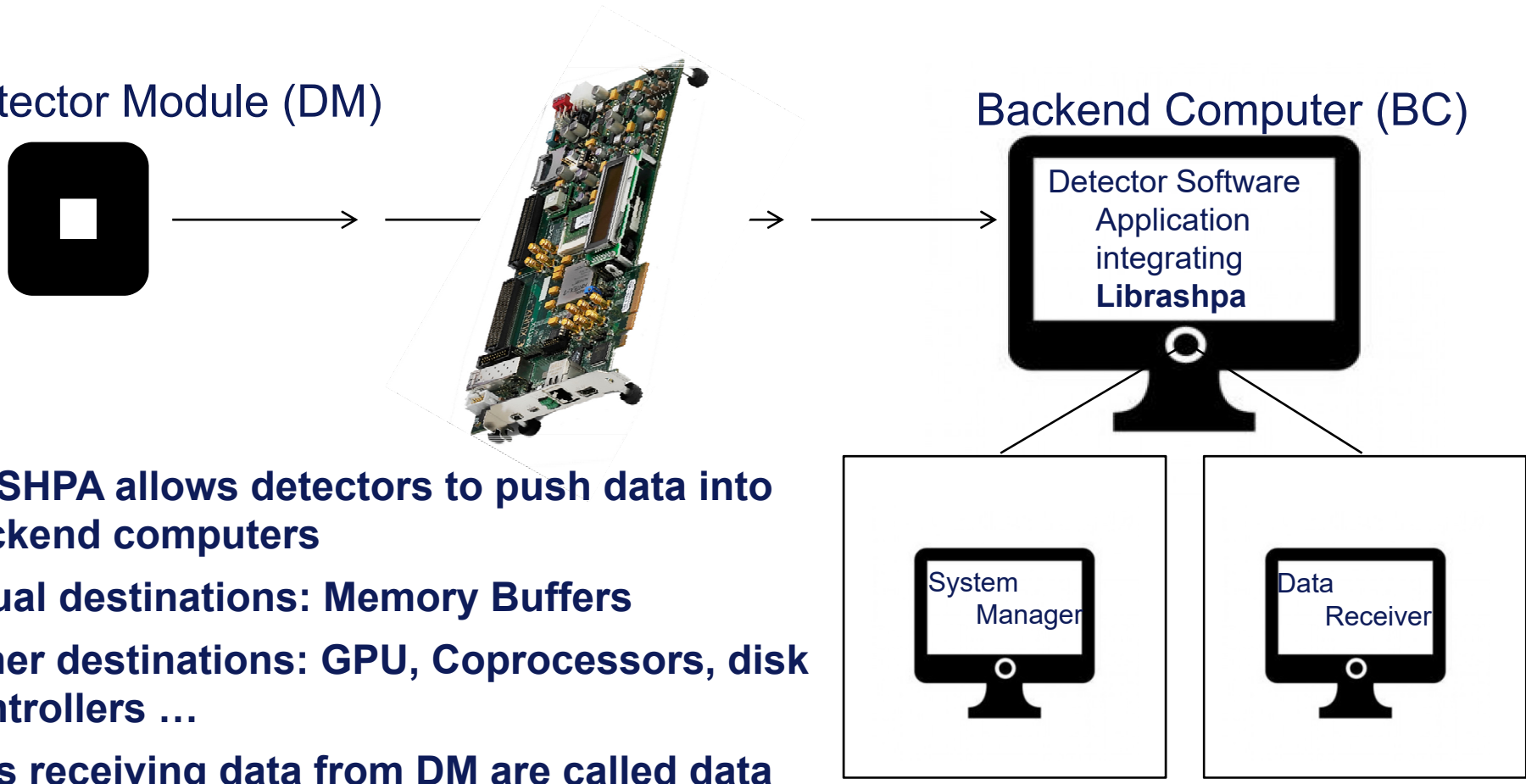


Scalability
- Support single or multiple sensors and workstations
- Adjustable bandwidth

Flexibility
- Adapt to detector geometry (offset, stride, …)
- Configurable data streams (image, ROI, event)
- Data transport layer (PCIe over Cable, 10 GbE)

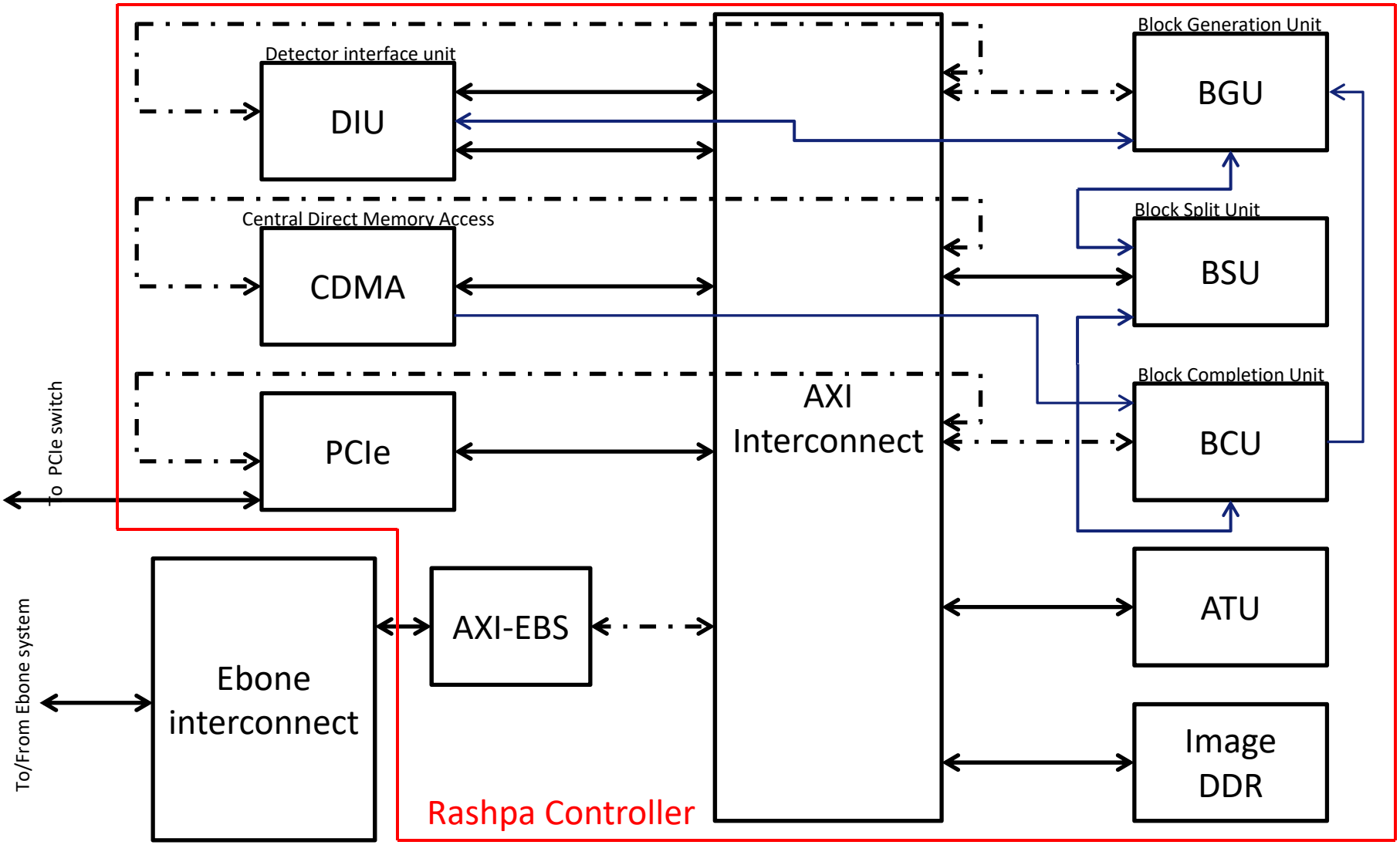
High Performance
- RDMA to copy data from source to memory buffer
- Multiple and simultaneous data streams

RASHPA CONCEPT



- **RASHPA allows detectors to push data into backend computers**
- **Usual destinations: Memory Buffers**
- **Other destinations: GPU, Coprocessors, disk controllers …**
- **BCs receiving data from DM are called data receivers (DR)**
- **BC that configures and initializes RASHPA is called System Manager (SM).**

RASHPA IMPLEMENTATION



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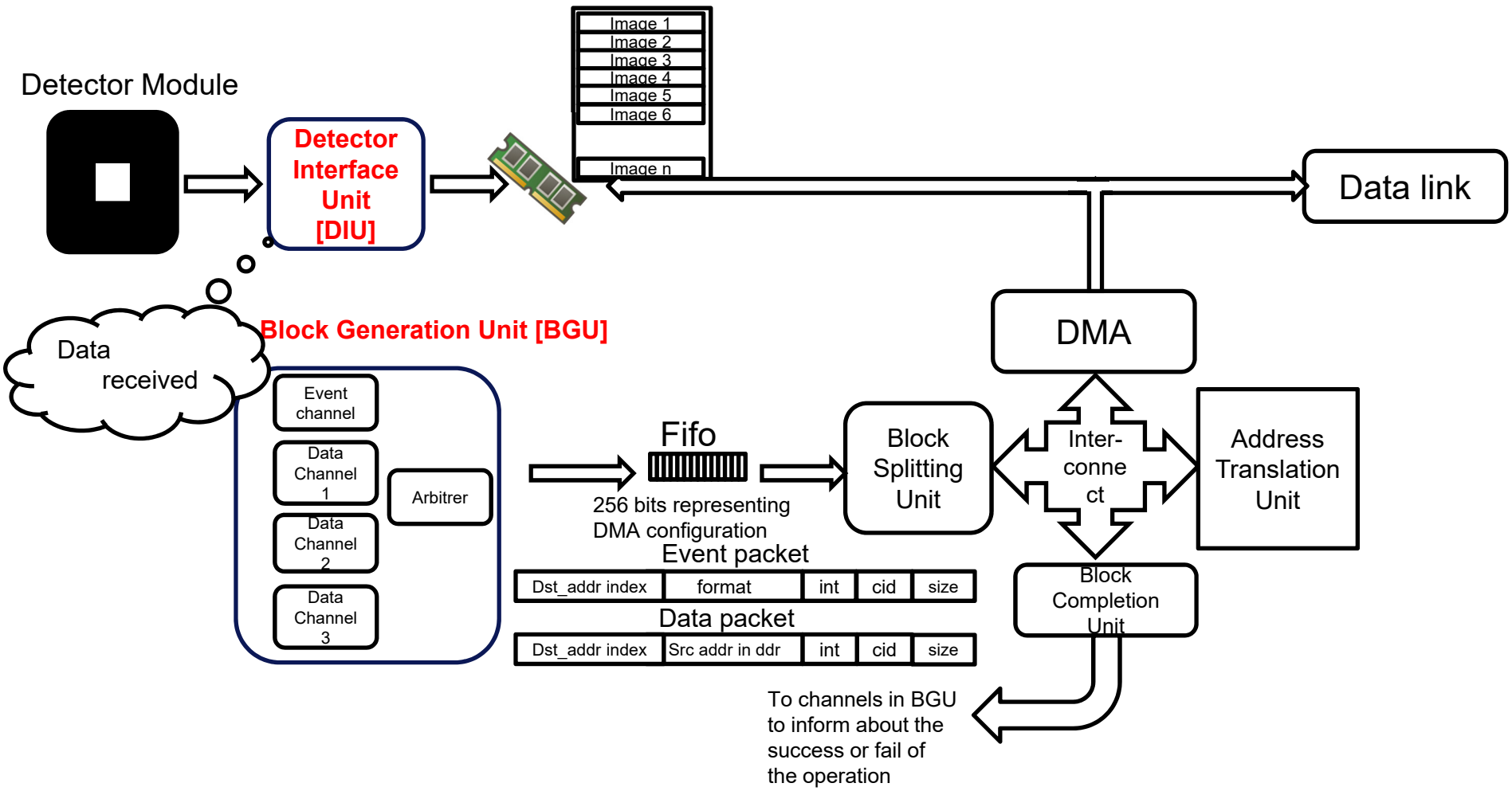
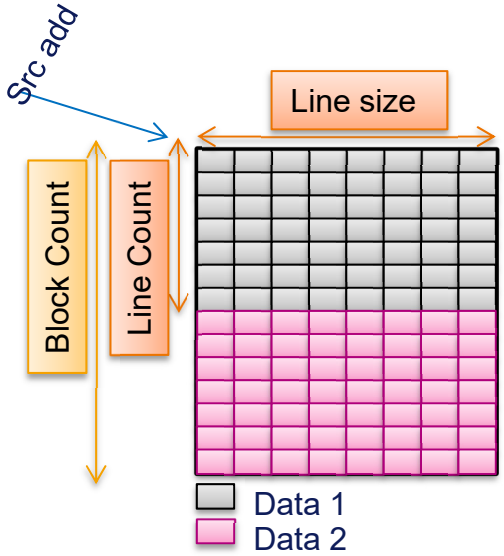
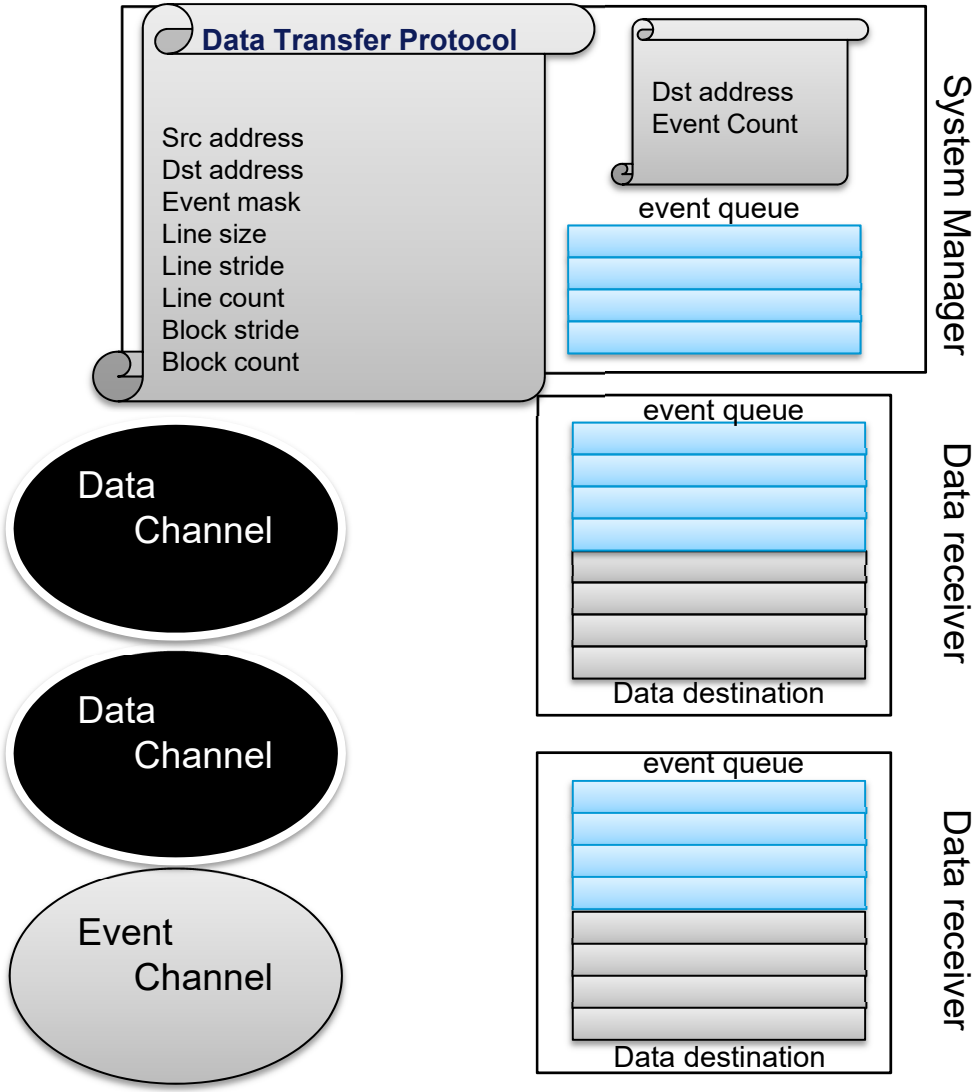


RASHPA IMPLEMENTATION

Data representation in RASHPA DDR





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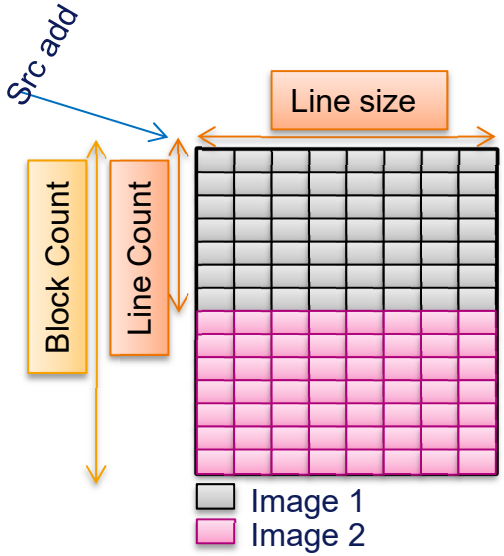

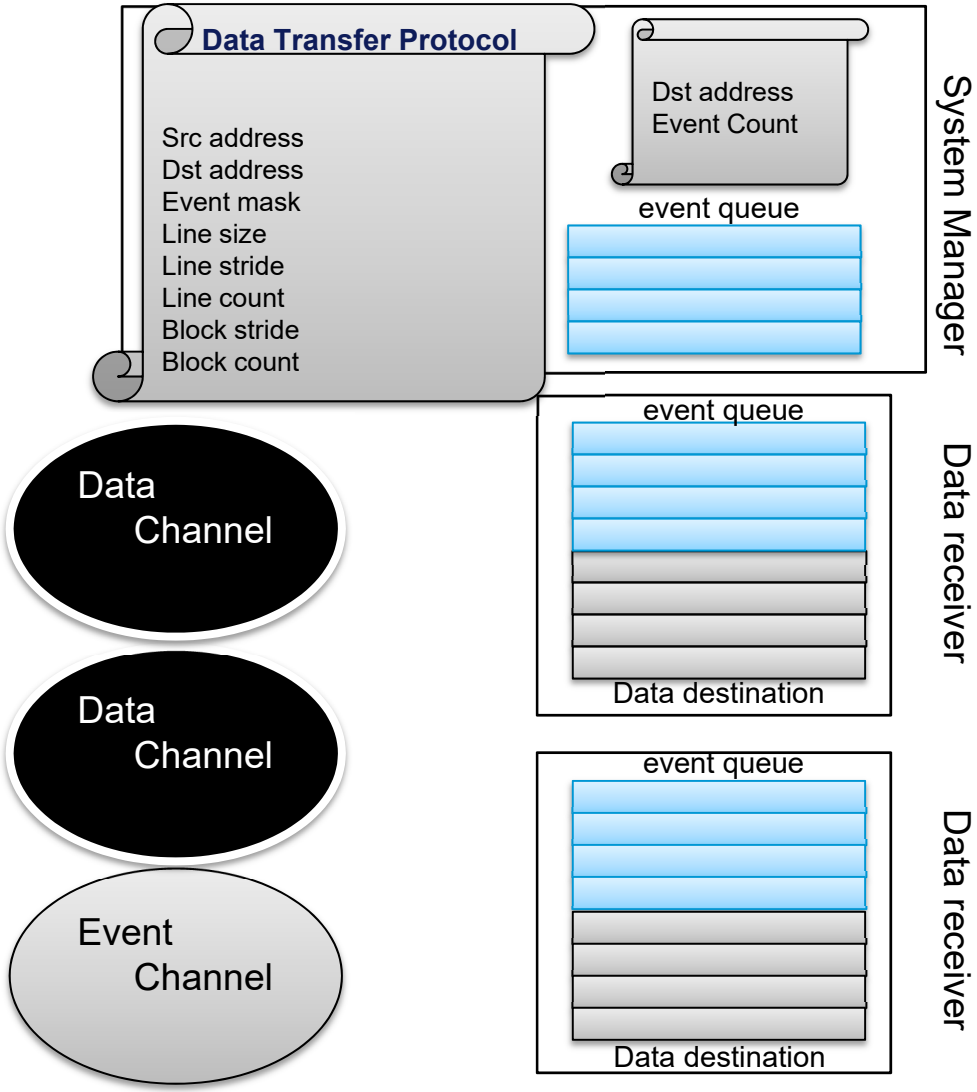

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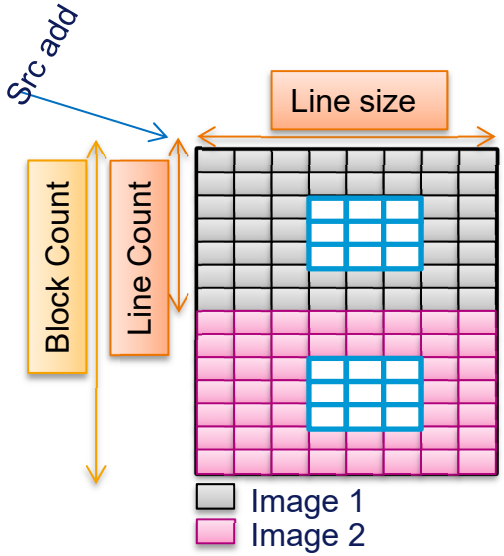

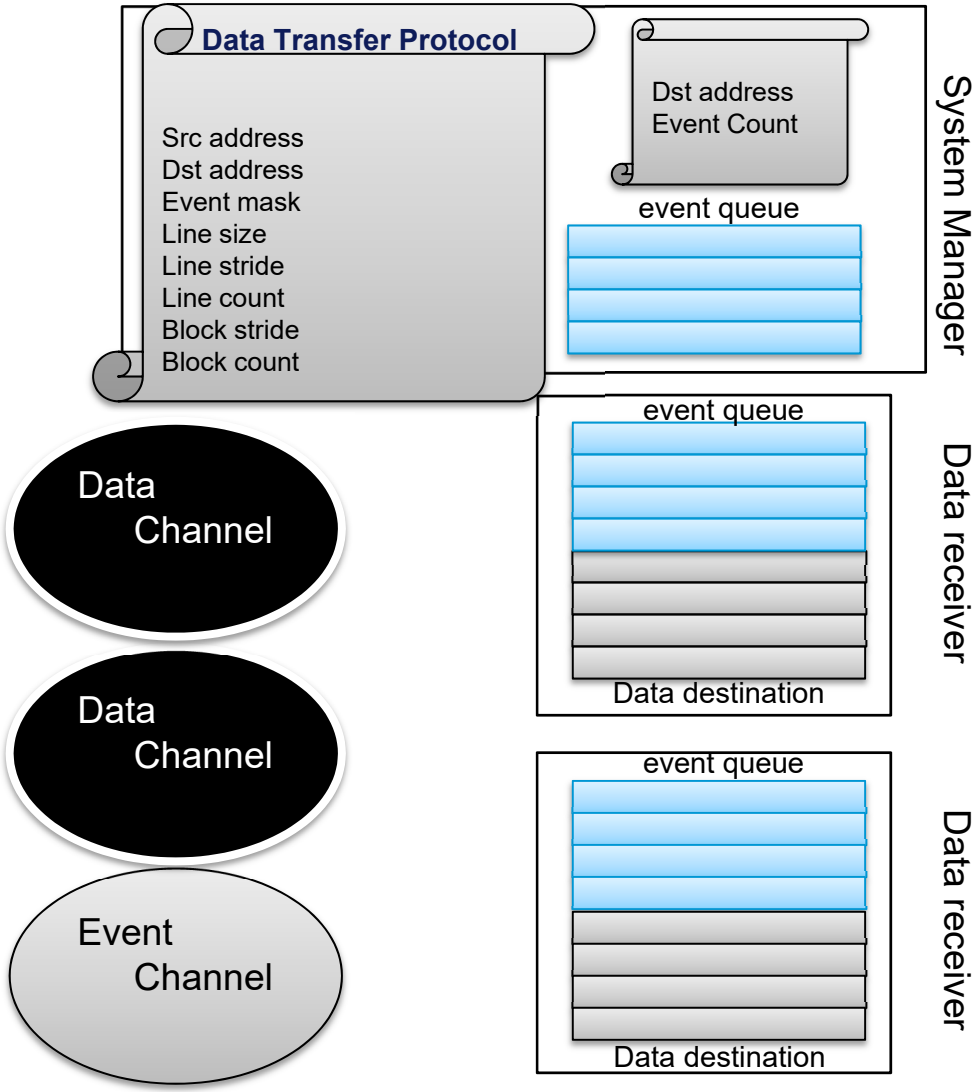

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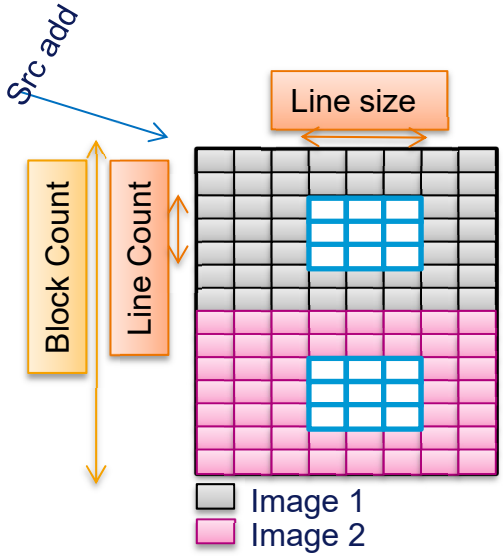

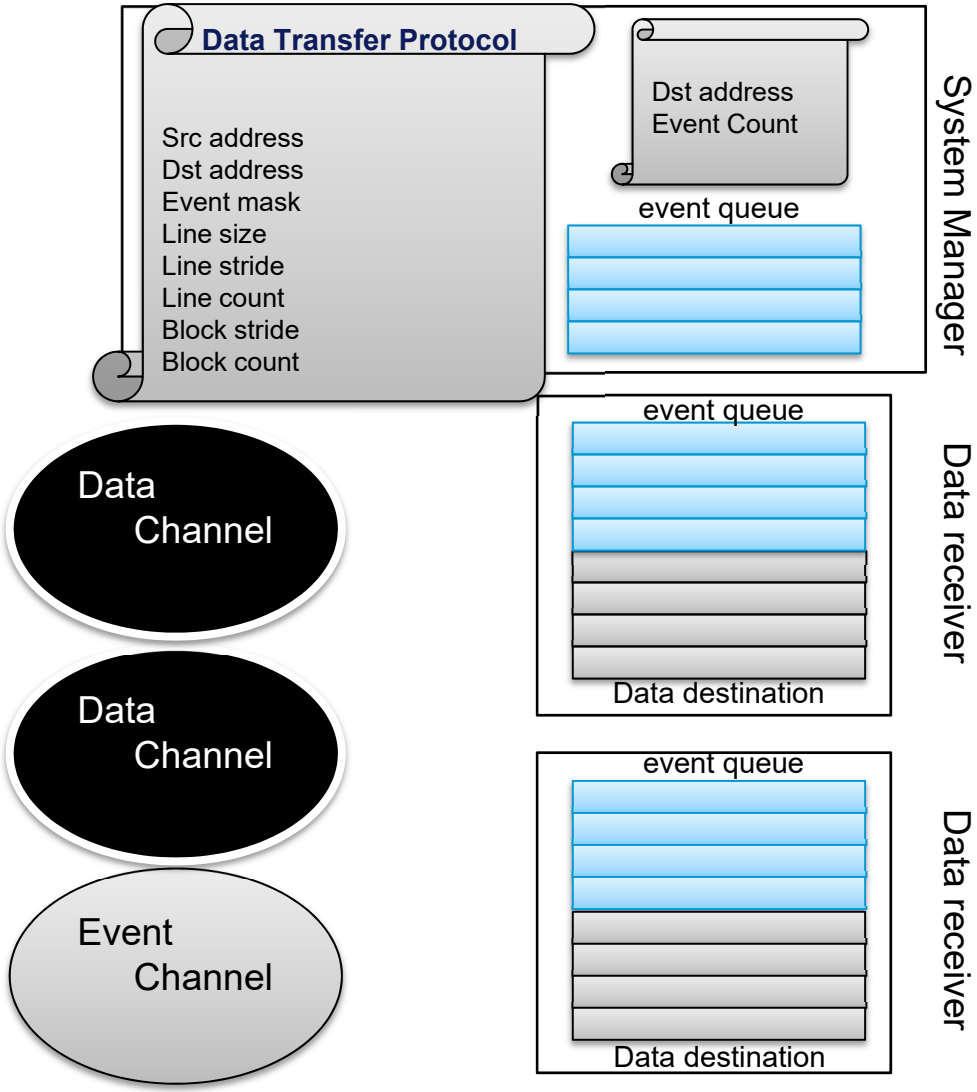

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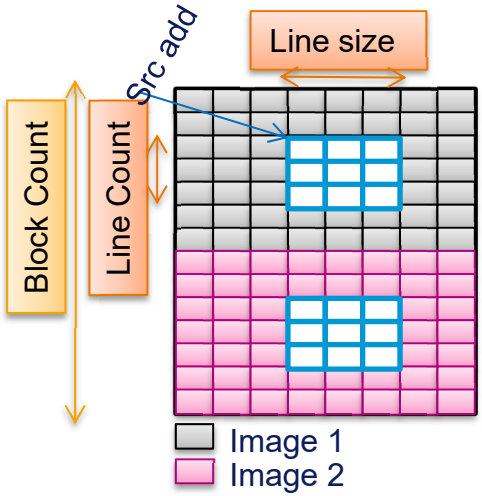

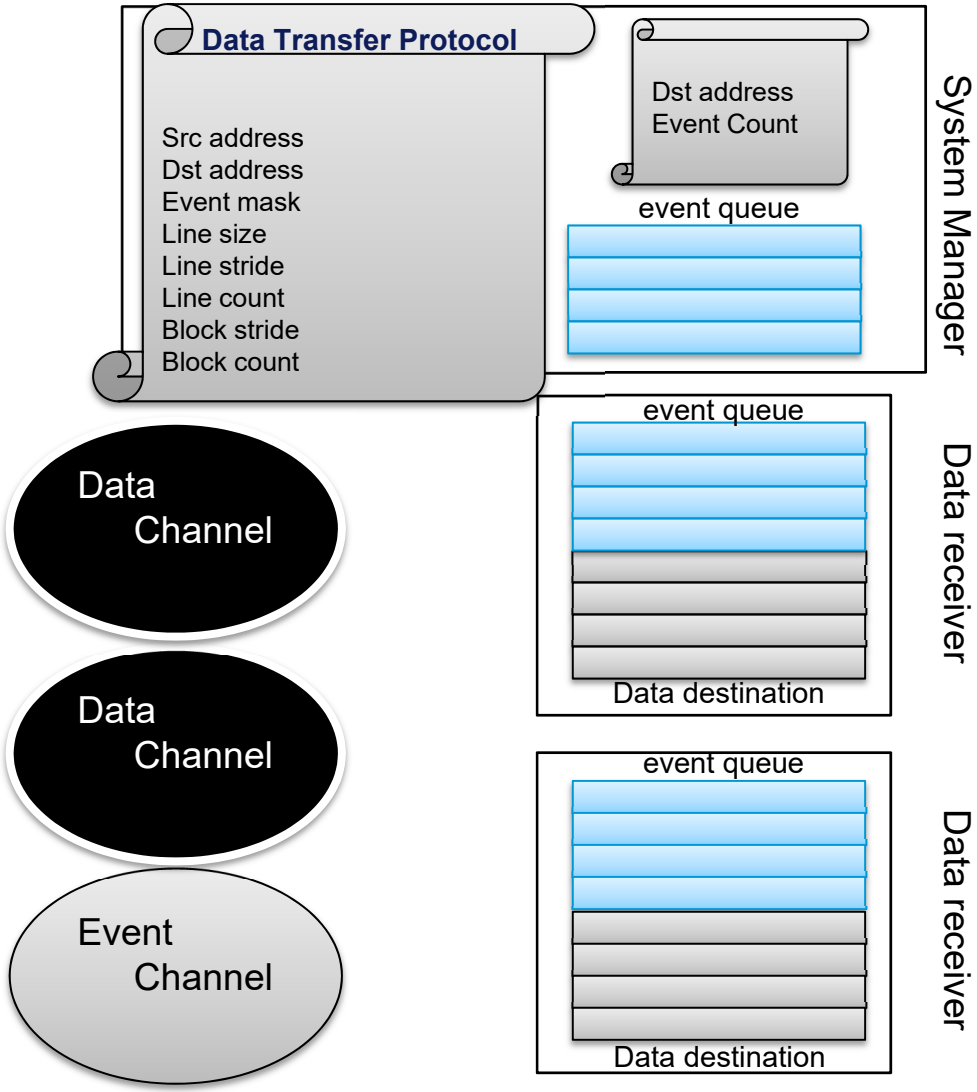

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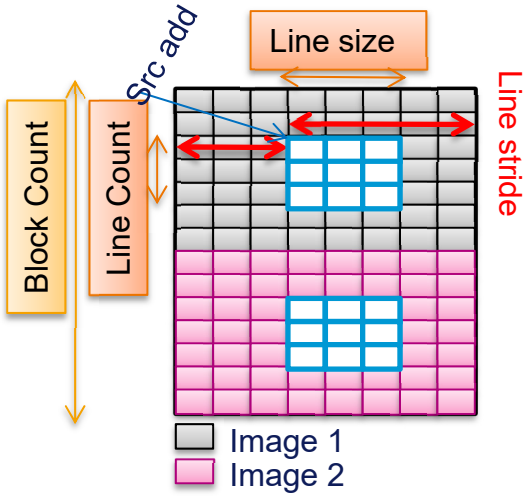

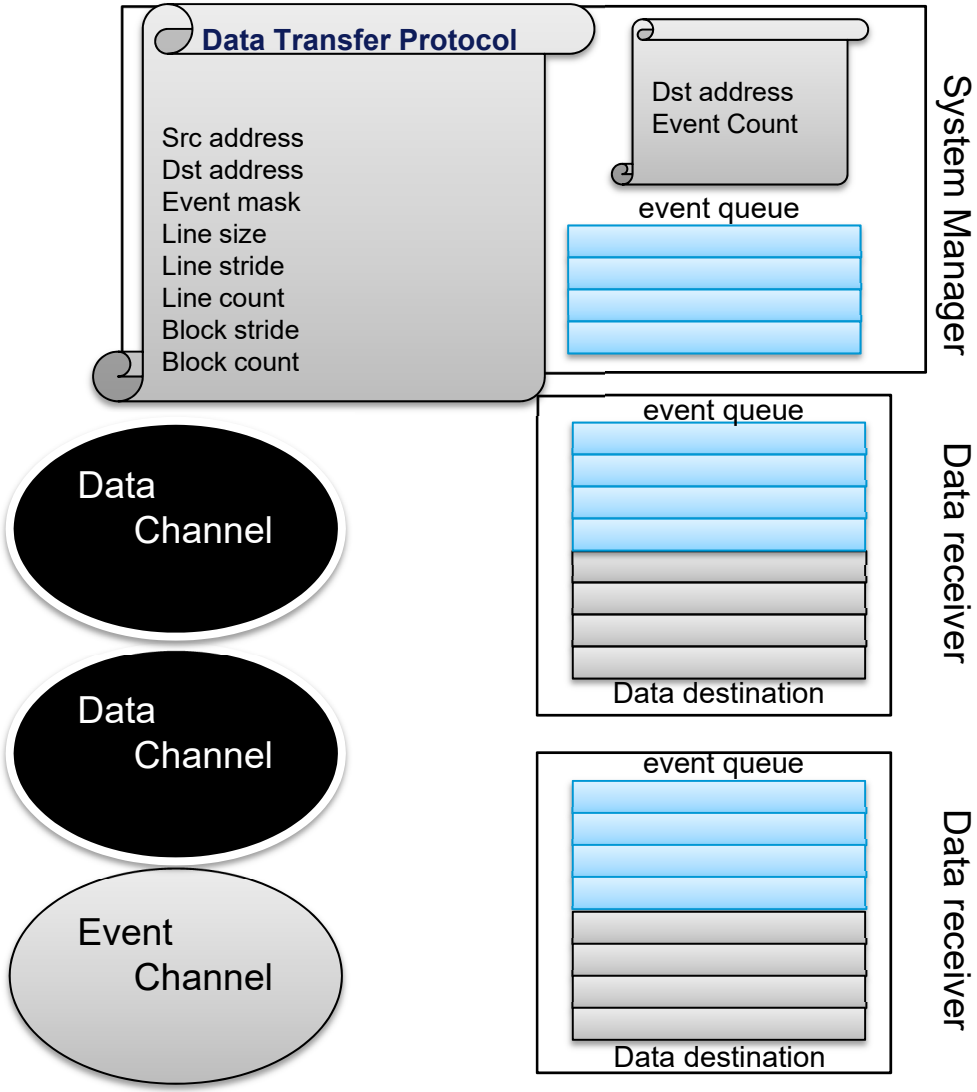

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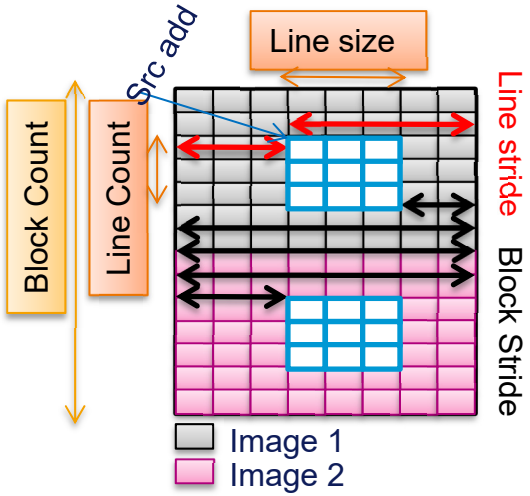
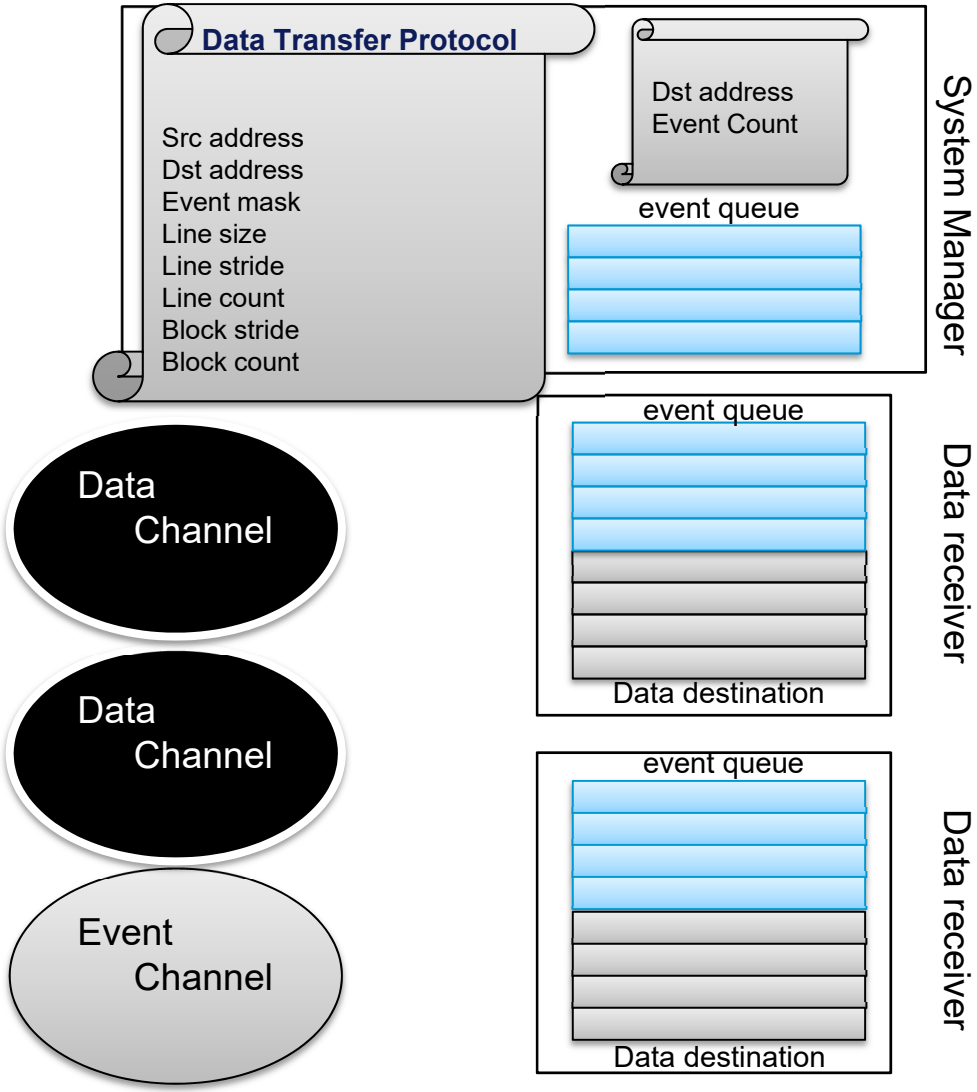
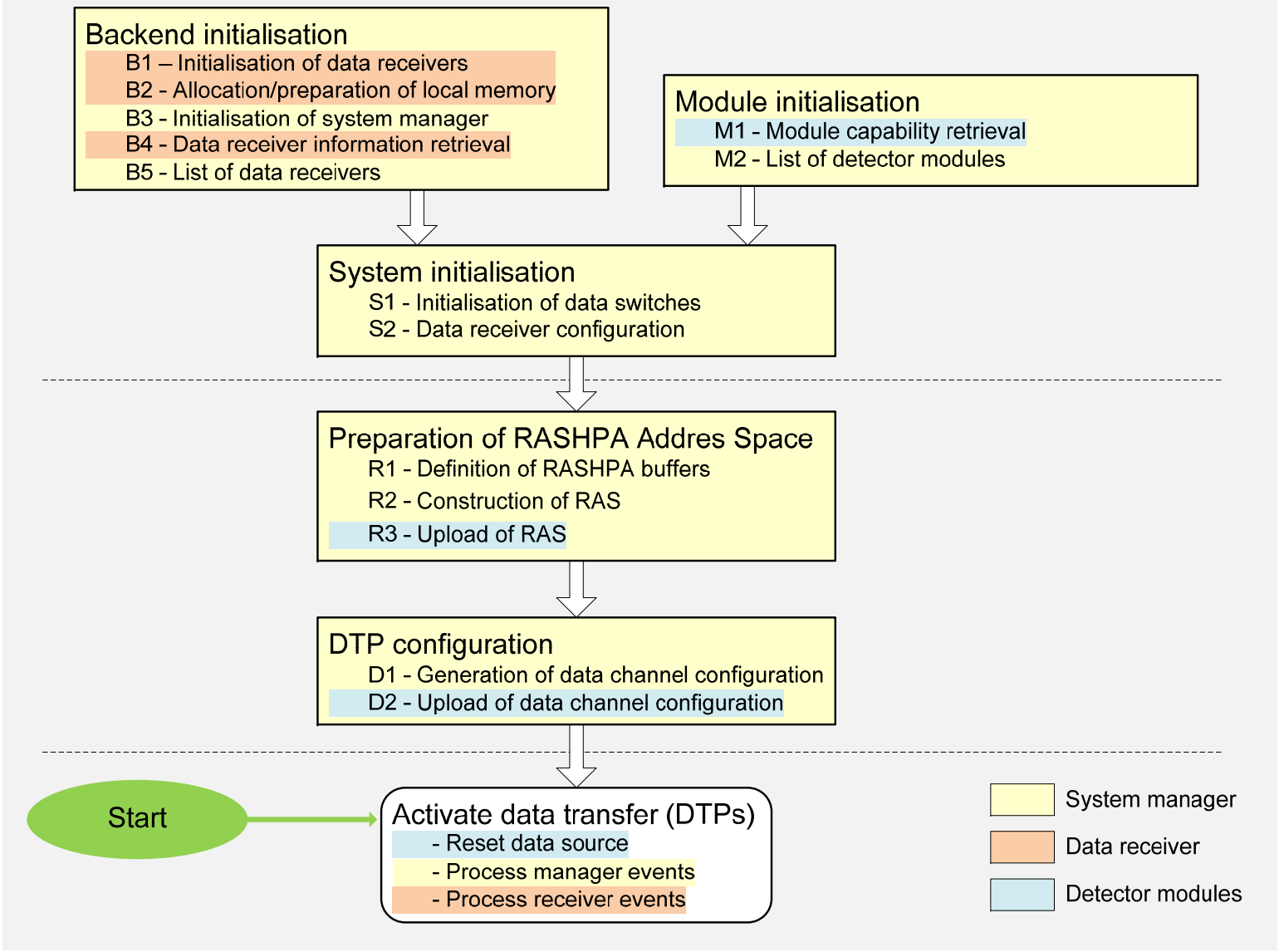




RASHPA IMPLEMENTATION - LIBRASHPA



RASHPA ADVANCED PROTOTYPE

Link Selection

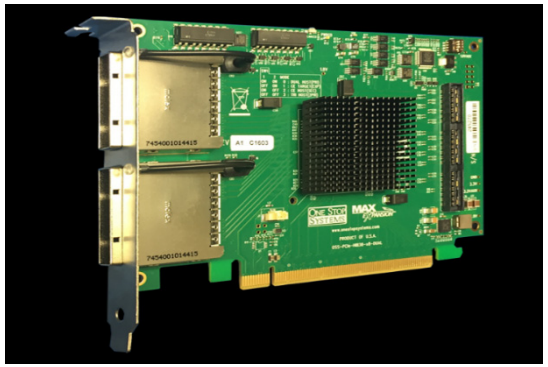
- PCIe over cable was selected for data transfer
  - Native integration
  - RDMA Capable
  - Limited Capabilities
  - Lack of Standardization

One Stop Systems switch

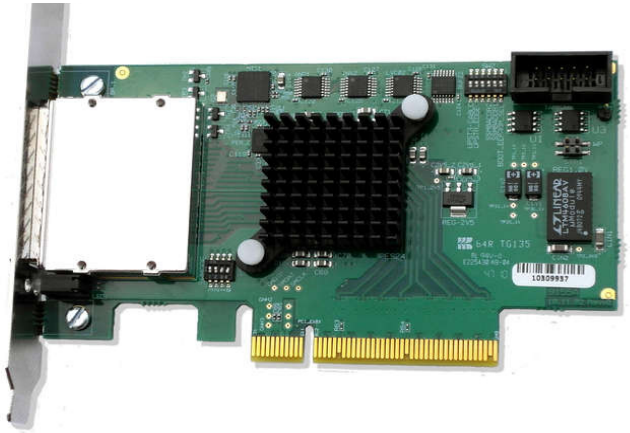
Dolphin IXS600

Supported link

One Stop Systems cable adapter



Dolphin PXH810



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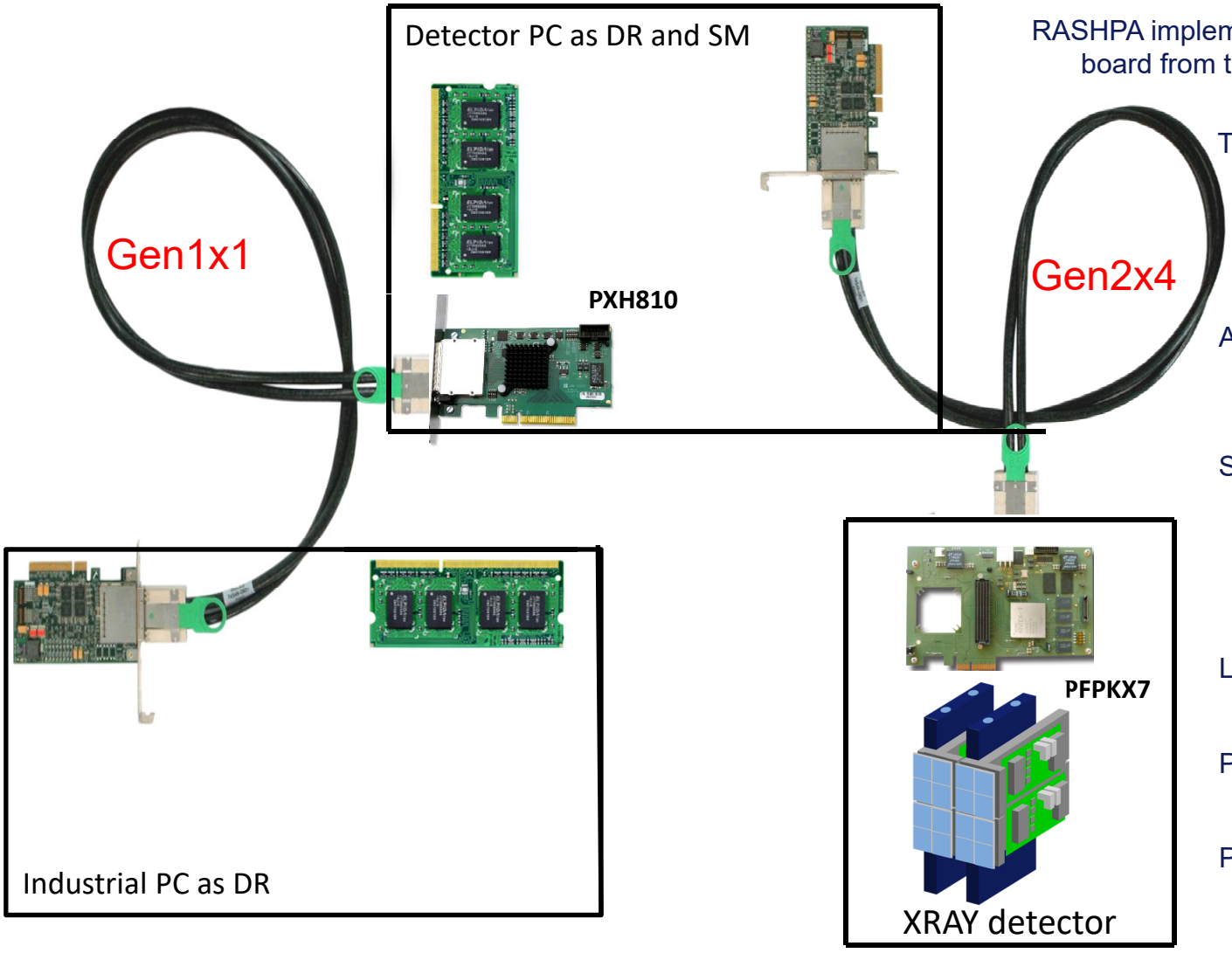


RASHPA implemented on PFPKX7 commercial board from techway

The system manager acts as a data receiver and implement the PCIe switching network.

An industrial PC is used as a second data receiver.

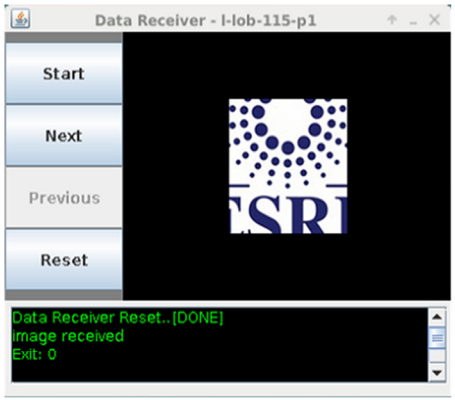
Smartpix detector is used as the XRAY detector for testing but replaced by an emulator to get significant data.

Linux based systems

PCIe IRQ driver

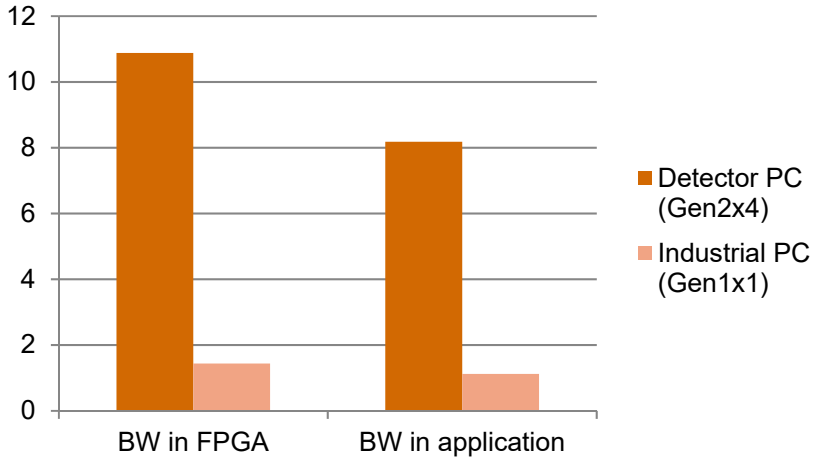
Physical memory driver

EXPERIMENTAL RESULTS



Performance Tests

	Bandwidth within the FPGA	Bandwidth when data available to the application
Detector PC Gen2x4	10.88Gbps 68%	8.18Gbps 51.15%
Industrial PC Gen1x1	1.44Gbps 71.99%	1.12Gbps 56.28%



CONCLUSIONS AND FUTURE WORK

Conclusions:

- Implementation of RASHPA Hardware
- Building routable RASHPA network based on PCIe over cable and PLX switches.
- Developing and testing the basic functionalities of librashpa for both system manager and data receiver.
- Integrating RASHPA with SMARTPIX detector
- Building an advanced RASHPA demonstrator.

Perspectives:

- Implementing RDMA based protocol over 100G Ethernet network
- Application of RDMA techniques in RASHPA to send data directly from the detector to GPUs in data receivers

THANK YOU FOR YOUR ATTENTION

Questions??