FELIX

A high-throughput network approach for interfacing to front end electronics for ATLAS upgrades

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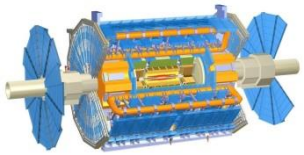
On behalf of the ATLAS FELIX Developer Team

ATLAS DAQ:



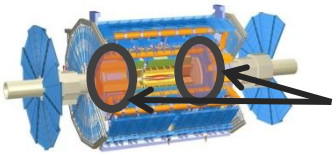
[1]Including ROS RobinNP

Today

Run 2 Run 3 Run 4

2015 2017 2019 2021 2023 2025

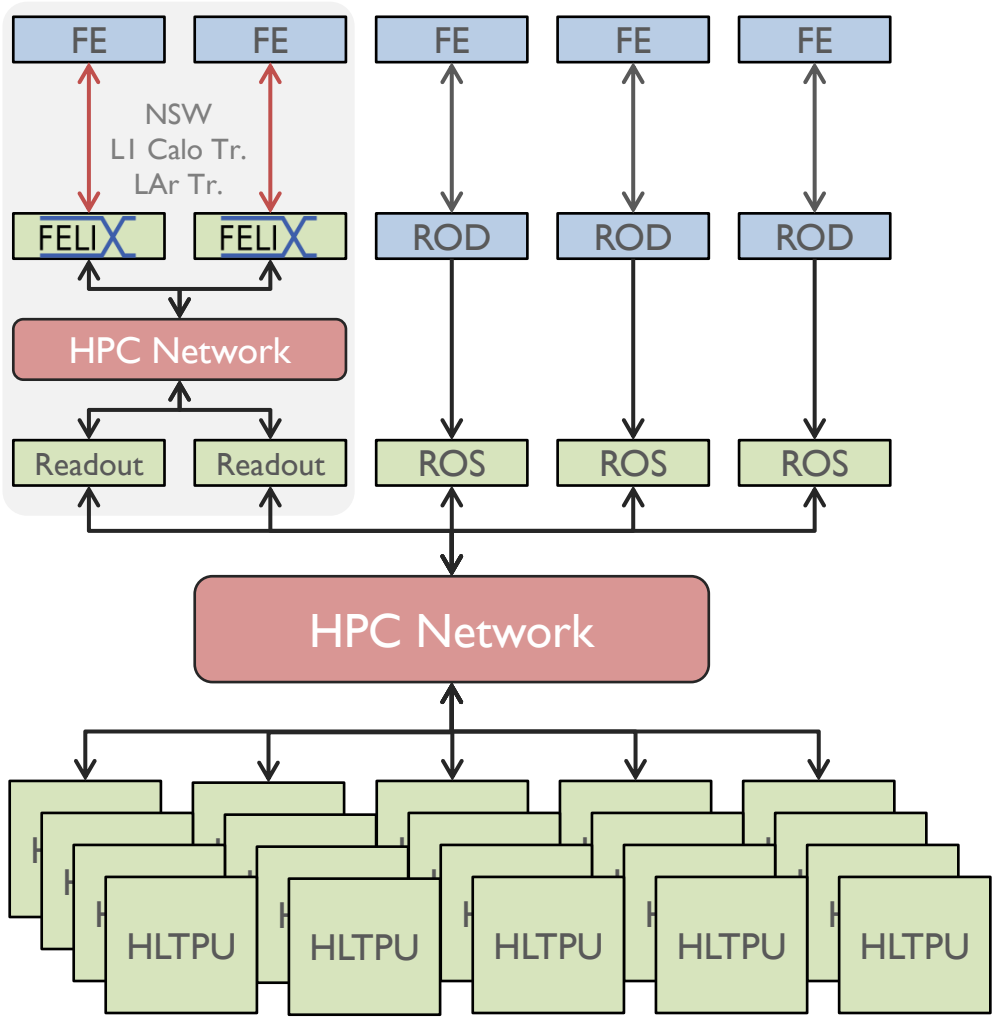
ATLAS DAQ:



Versatile Link, GBT

PCs

40 Gb Ethernet, Infiniband

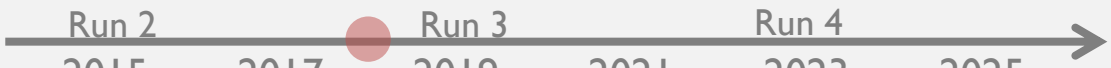


High-Level Trigger Farm

Custom electronic components

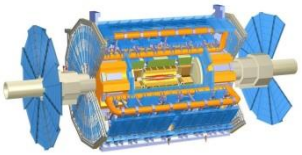
PCs (COTS)

2018



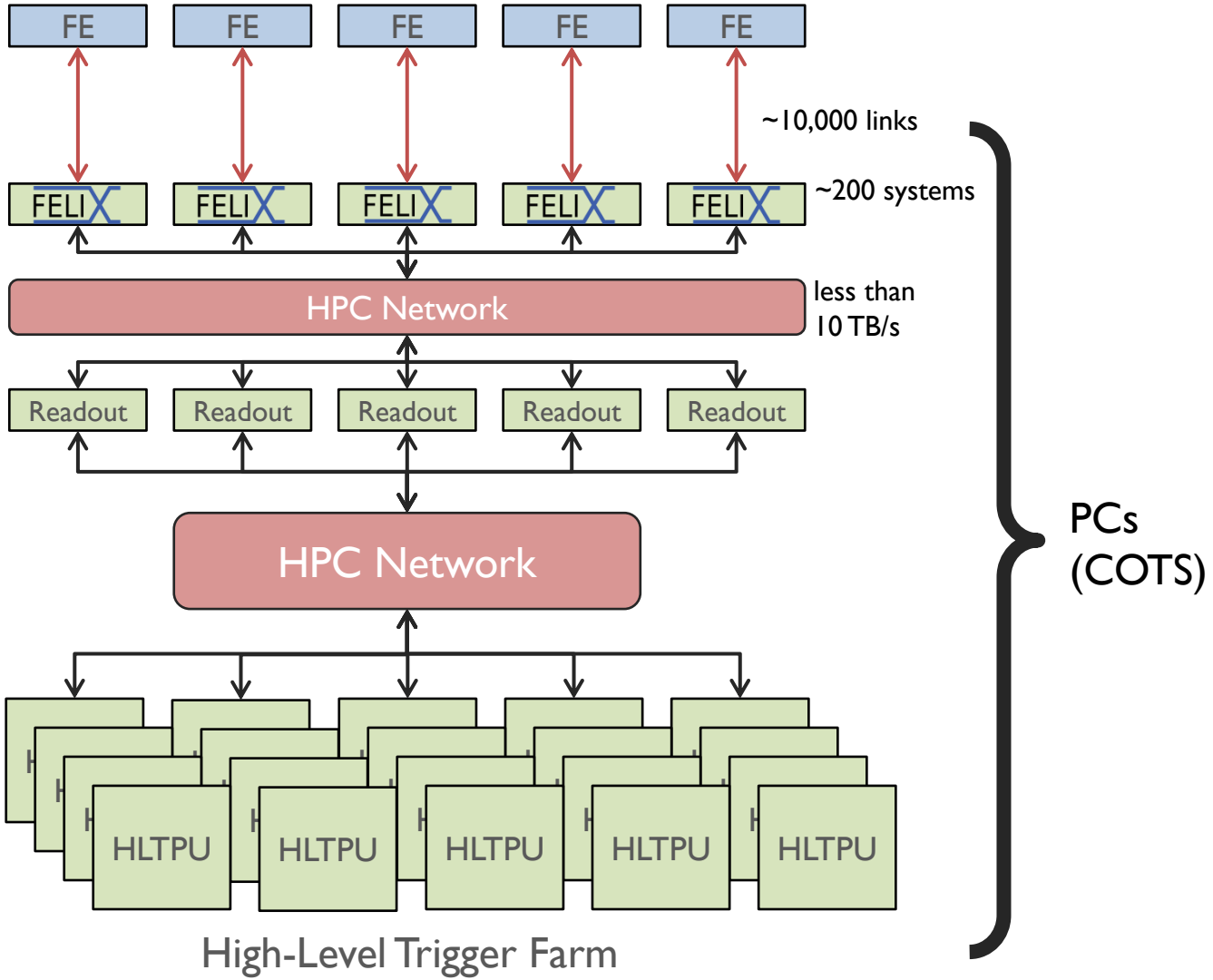
ATLAS DAQ:

40 MHz



Versatile Link,
GBT, LpGBT

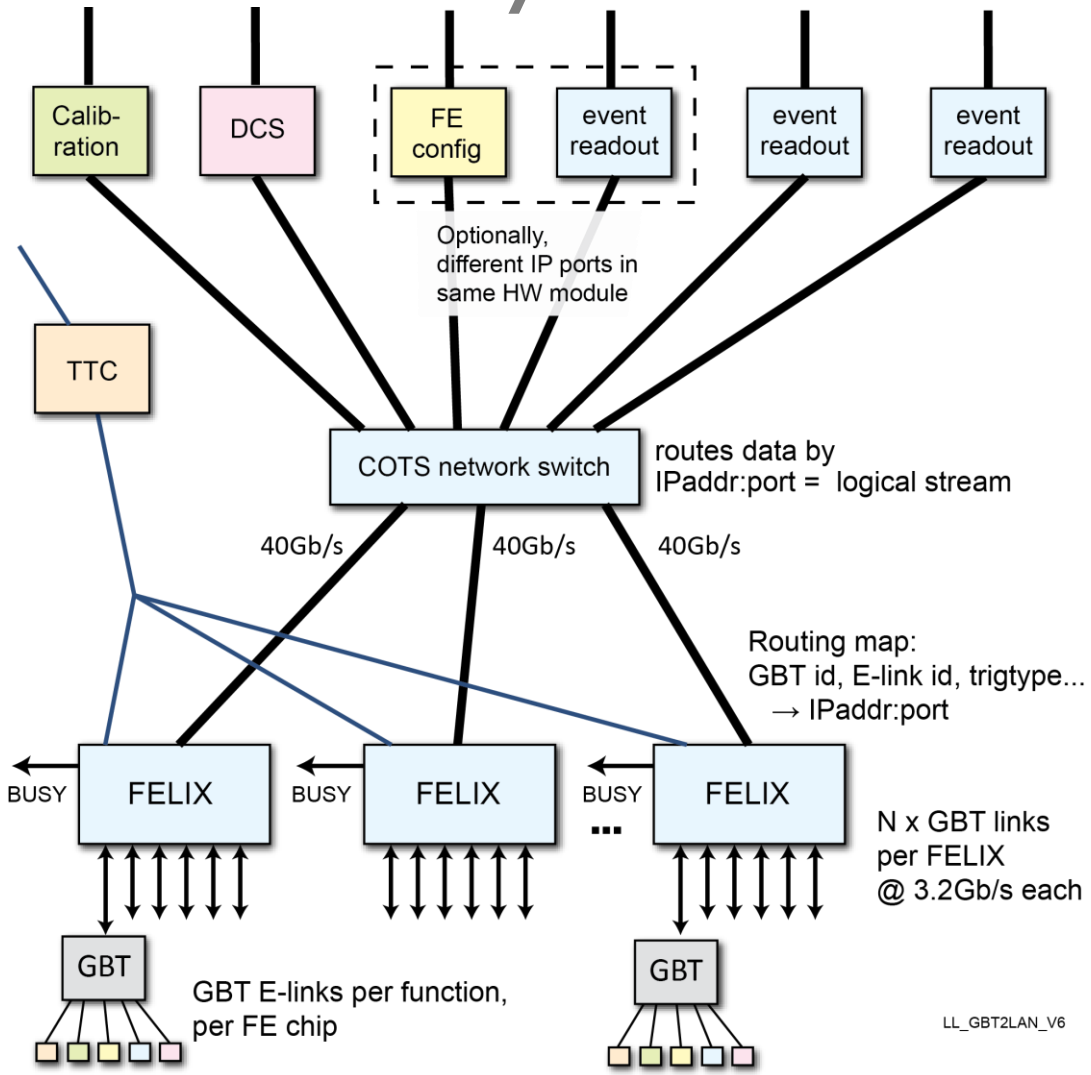
COTS network
technology



2023

Run 2 2015 | 2017 | Run 3 2019 | 2021 | Run 4 2023 | 2025

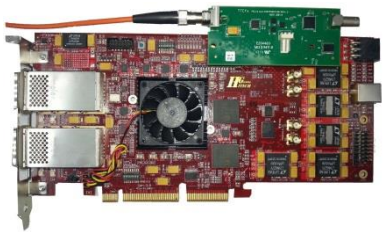
Functionality



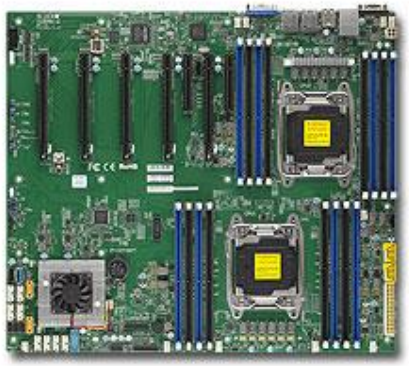
E-link: variable-width logical link on top GBT. Can be used to logically separate different streams on a single link.

- Scalable architecture
- Routing of multiple traffic types: physics events, detector control, configuration, calibration, monitoring
- Industry standard links: data processors/handlers can be SW in PCs - Less custom electronics, more COTS components
- Reconfigurable data path, multi-cast, cloning, QoS
- Automatic failover and load balancing
- TTC integration, LHC clock distribution

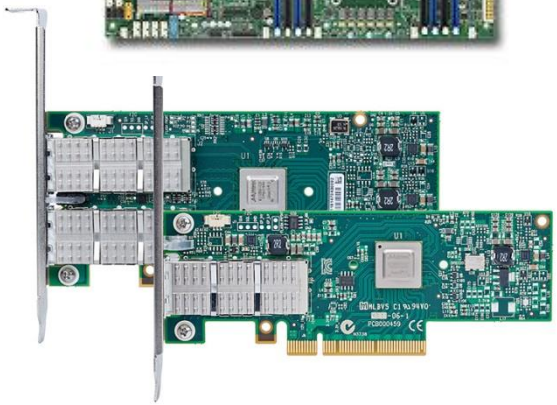
Development Platform



HiTech Global PCIe development
Xilinx Virtex-7
PCIe Gen-2/3 x8
24 bi-directional links
http://hitechglobal.com/Boards/PCIE-CXP.htm
With custom TTCfx FMC



SuperMicro X10DRG-Q
2x Haswell CPU, up to 10 cores
6x PCIe Gen-3 slots
64 GB DDR4 Memory
http://supermicro.com/products/motherboard/Xeon/C600/X10DRG-Q.cfm



Mellanox ConnectX-3 VPI
FDR/QDR Infiniband
2x10/40 GbE
http://www.mellanox.com/page/products_dyn?product_family=119&mtag=connectx_3_vpi

Memory

CPU

DMA

MSI-X

Custom Device Driver

FELIX Application

FPGA Card

TTC FMC

DMA

Config

GBT

Elink router

24 – 48 links

Optical Links

64 Gb/s

PCIe Gen-3

Large Buffers per group of elinks

64 Gb/s

PCIe Gen-3

NIC

2 – 4 40-Gb/s ports

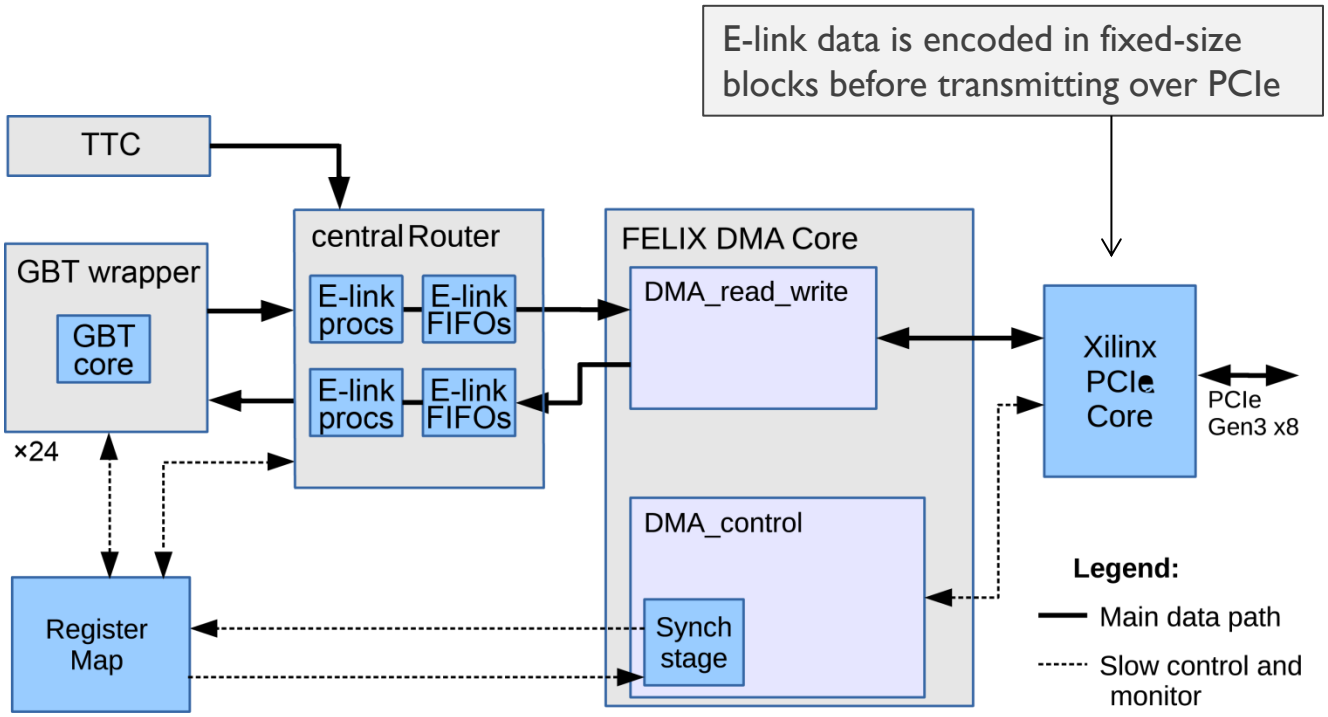
Optical Links

FELIX

"TTC" is the Timing, Trigger and Control System

FELIX Demonstrator System

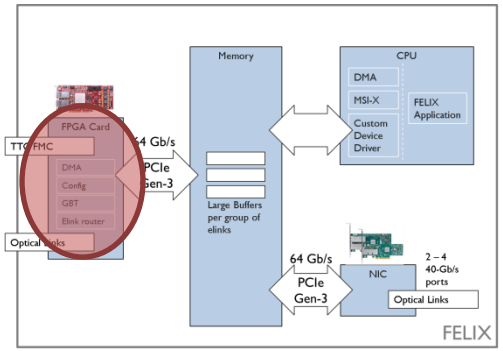
Demonstrator Firmware Design



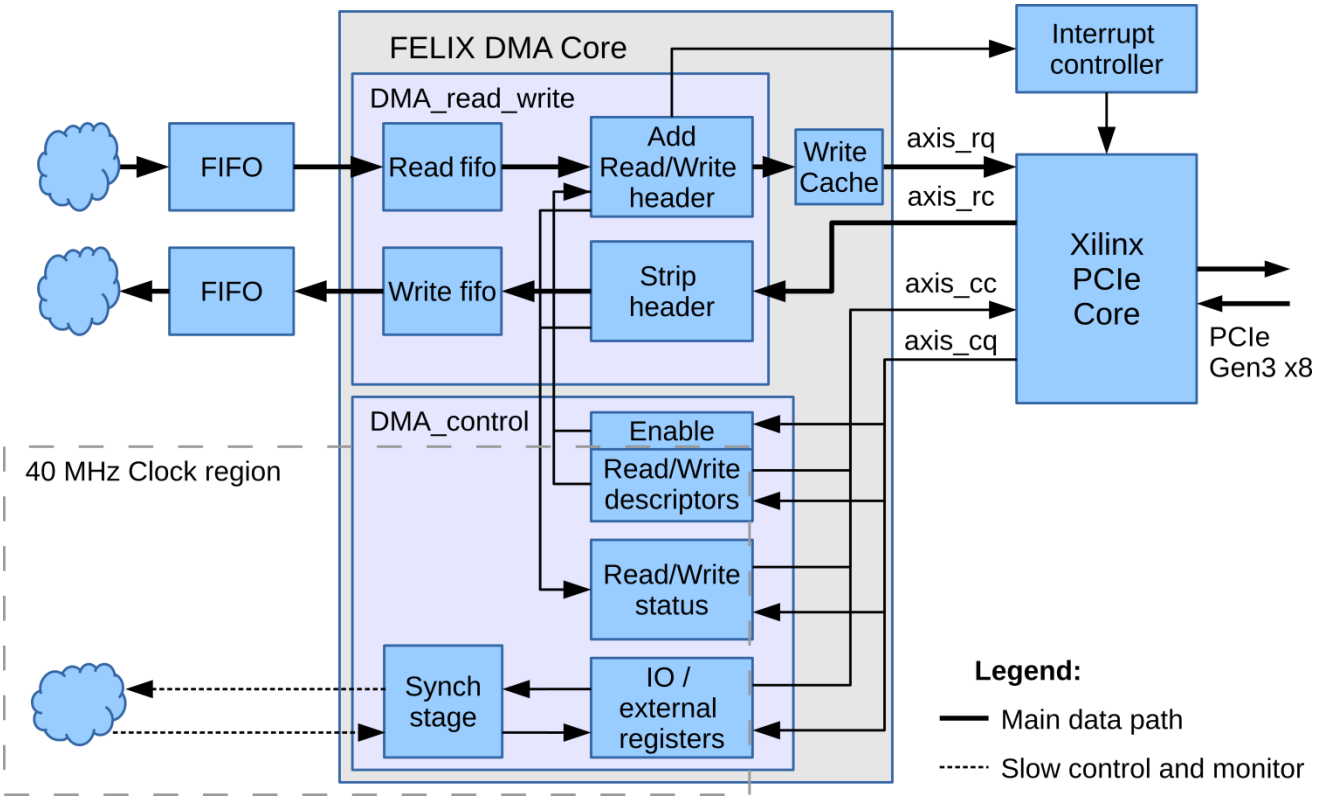
Different GBT modes (normal, wide, …) supported

Connection to legacy TTC system via FMC

Internal data generator for testing



FELIX DMA Core

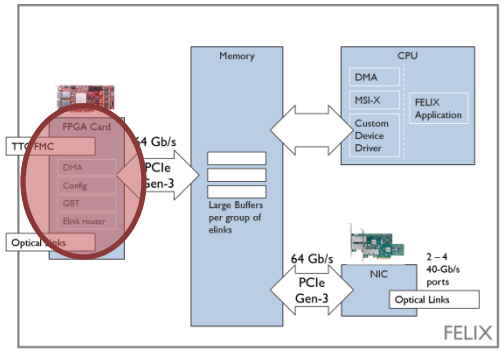


DMA interface to the Xilinx Virtex-7 PCIe Gen3 hard block

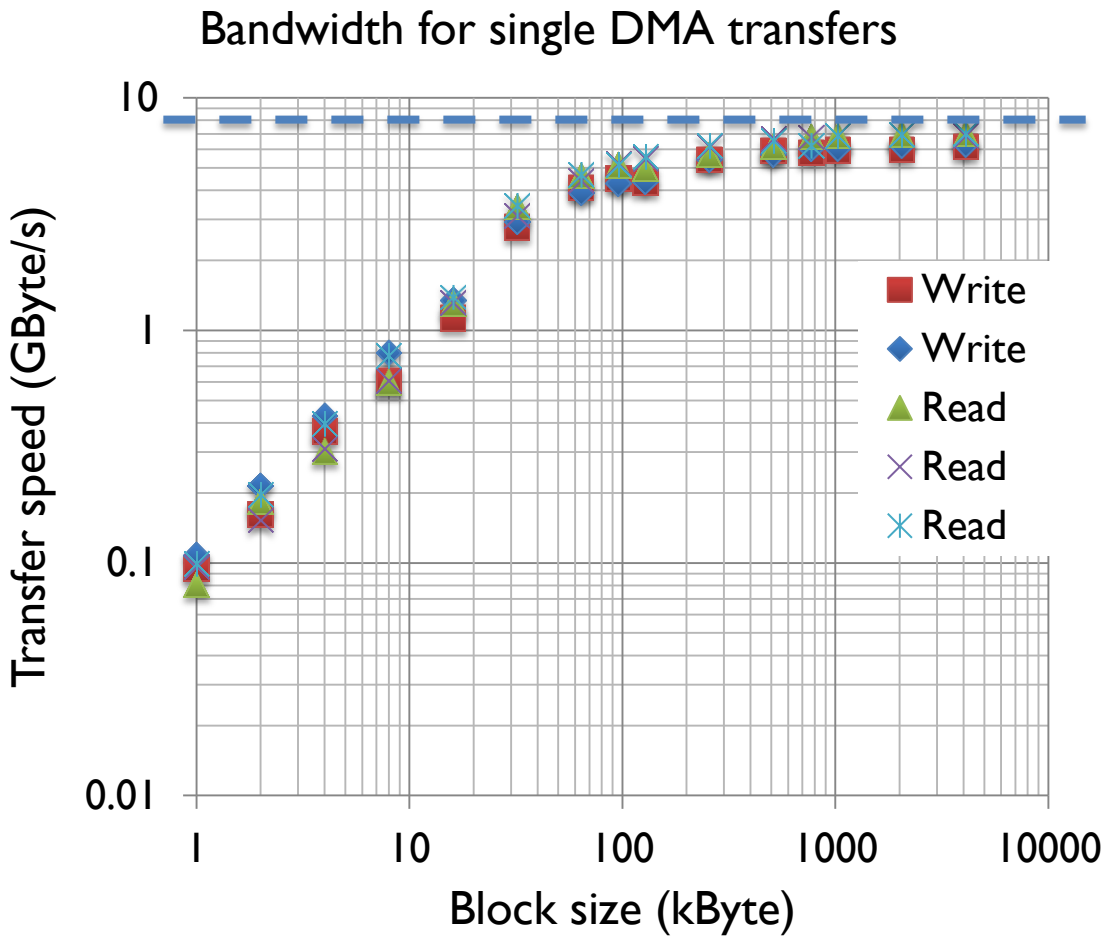
MSI-X compatible interrupt controller

Developed at Nikhef for use in FELIX

Published as OpenSource (LGPL) on OpenCores
http://opencores.org/project,virtex7_pcie_dma

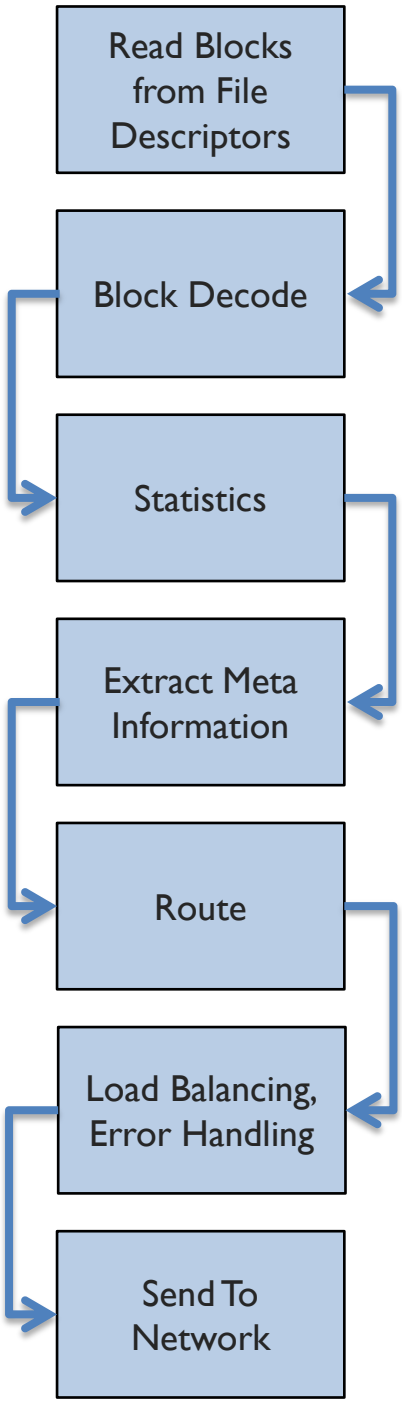


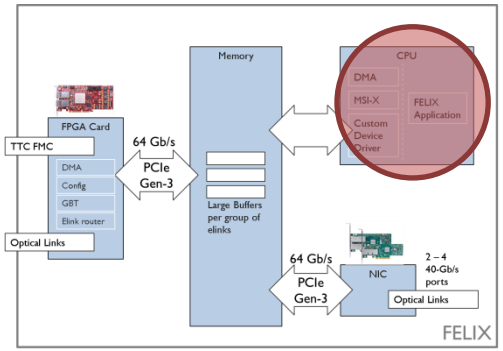
DMA Core Benchmarks



Speed of transfers into/from a single buffer in host memory was measured for different block sizes

CPU Data Processing Pipeline





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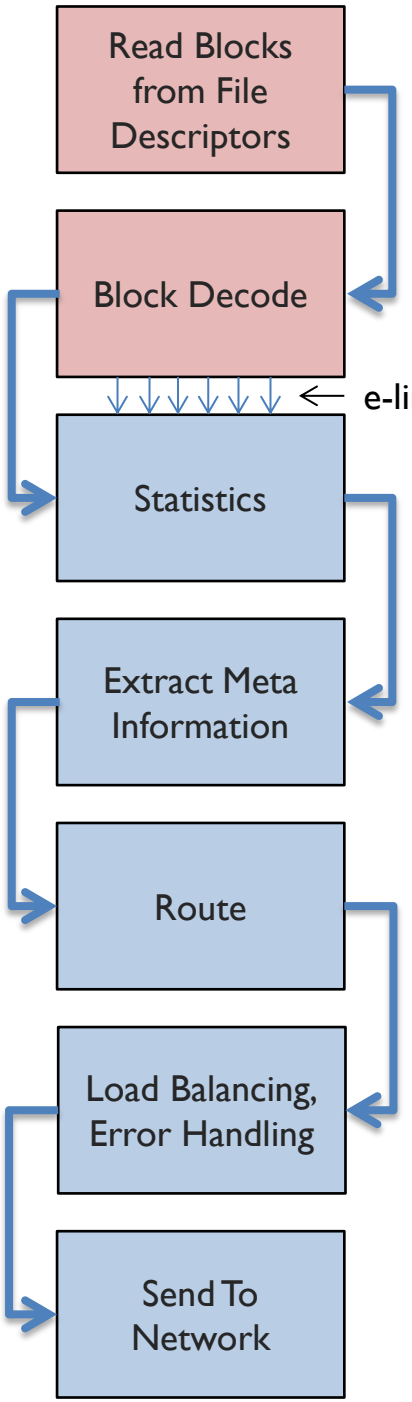
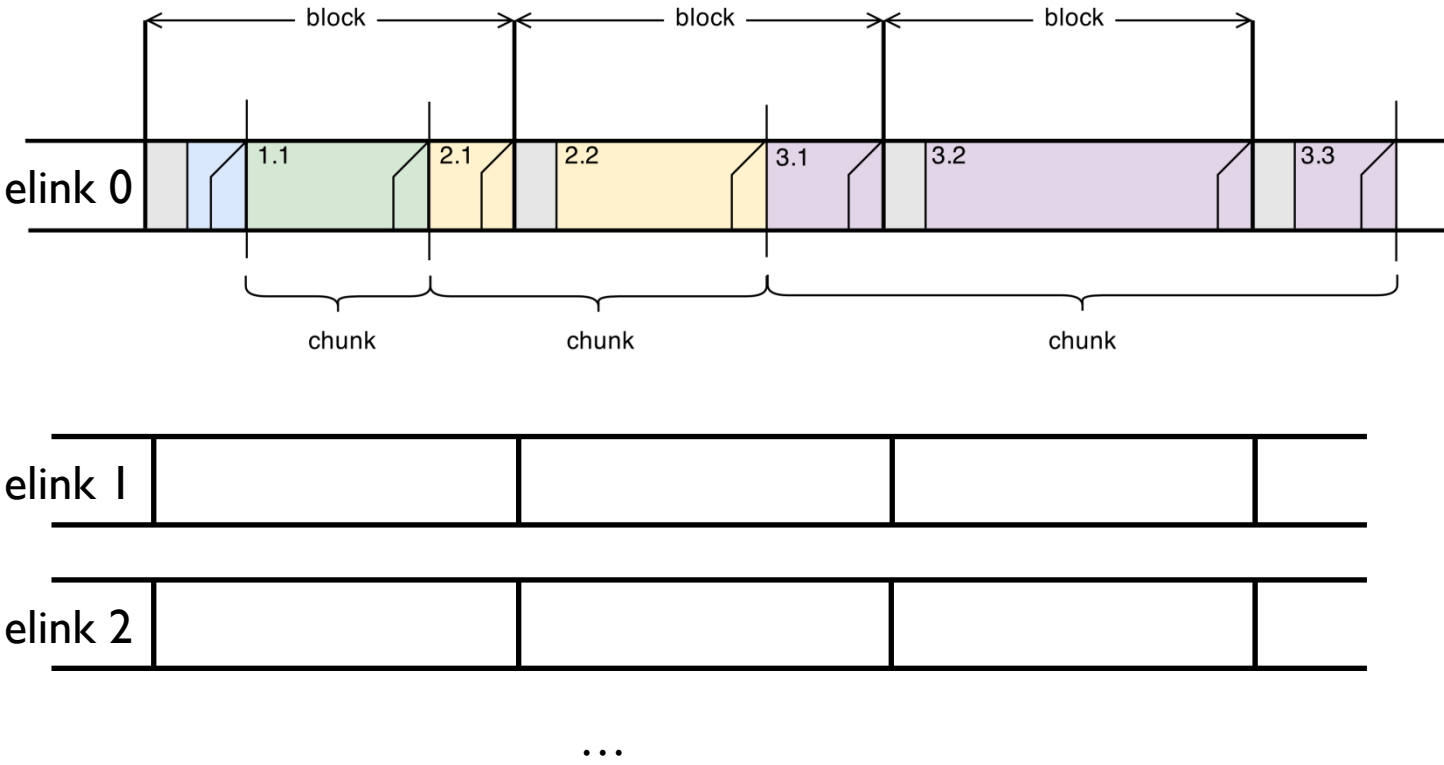


Program DMA transfers and read fixed blocks of data that have been encoded for the transfer over PCIe

Decode into variable sized chunks for transmission over network



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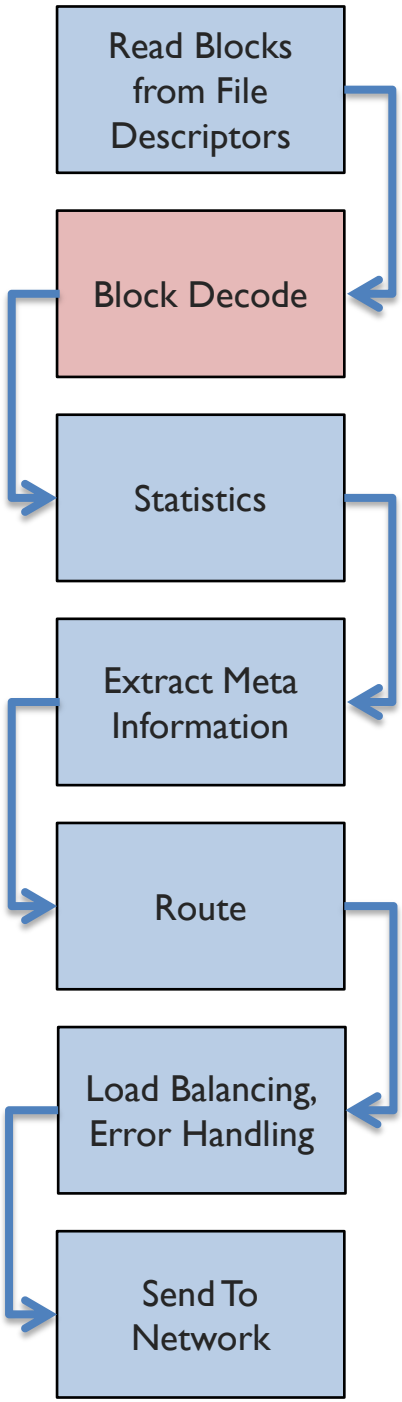
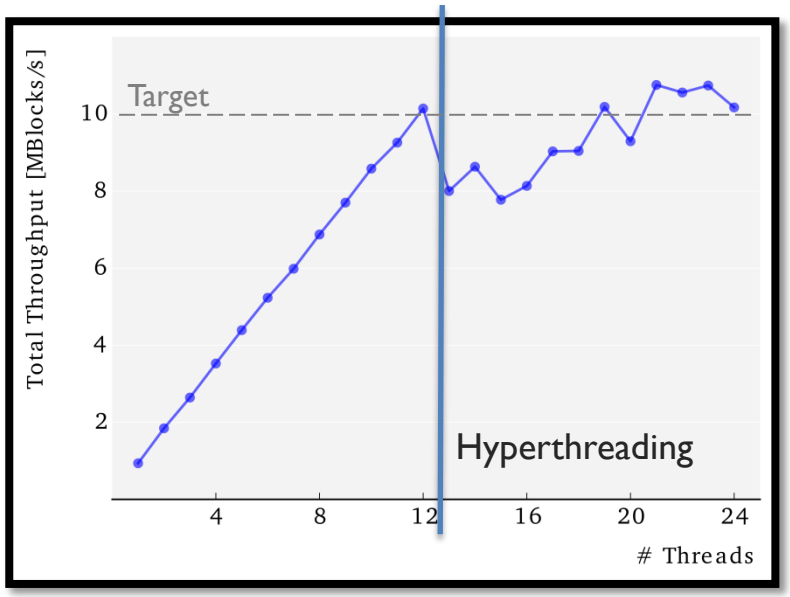
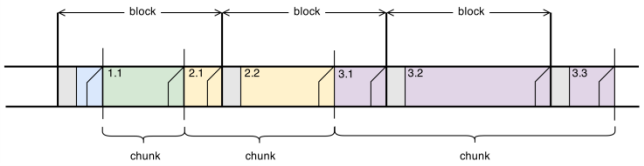
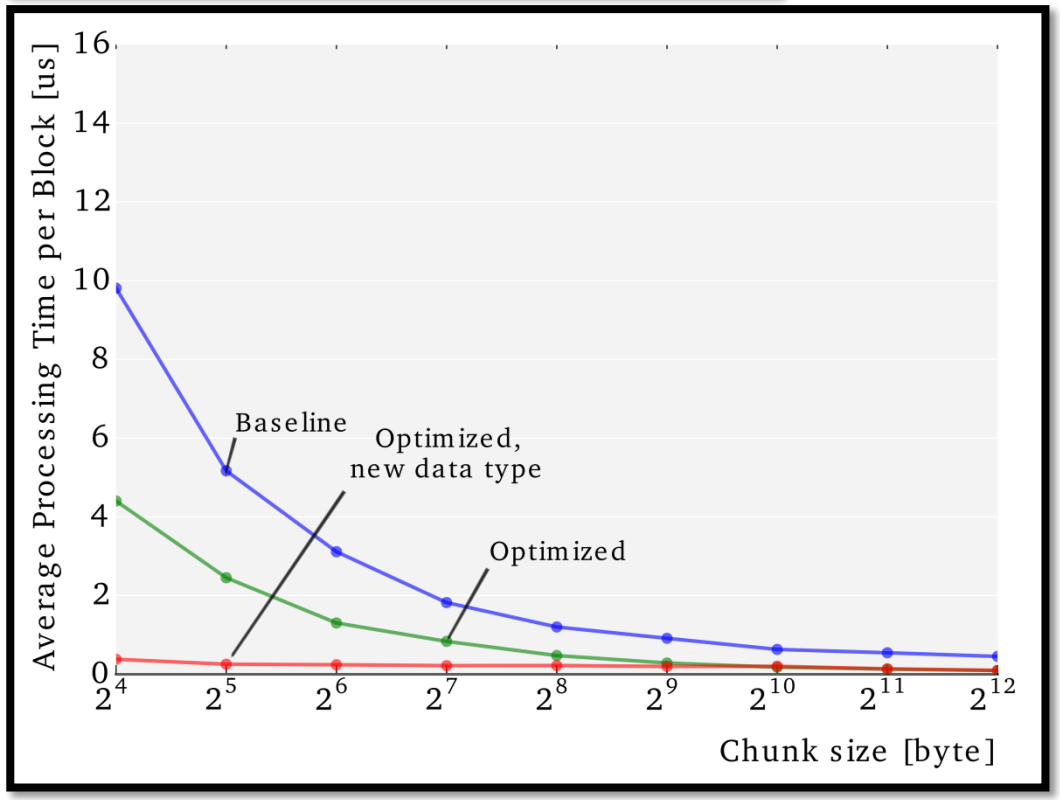


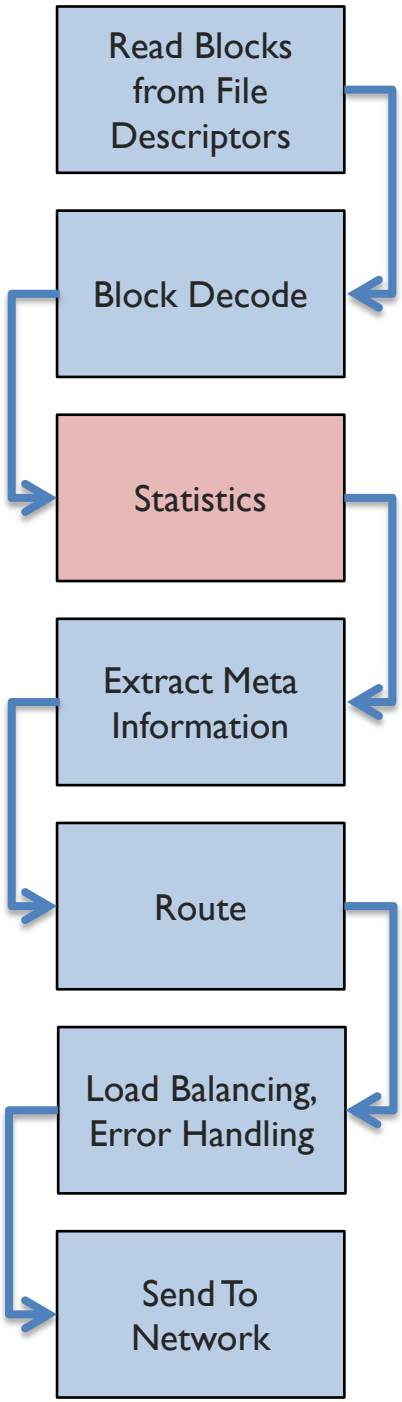






- Optimizations targeting memory throughput
- More efficient data layout
- Better use of STL containers

CPU Data Processing Pipeline



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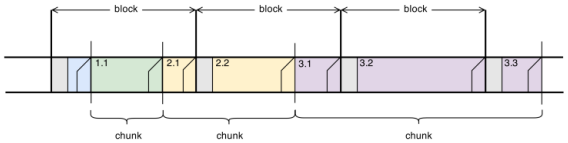
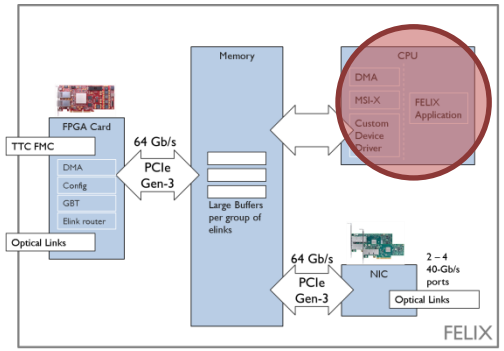


Count processed blocks, transfer rates, etc.



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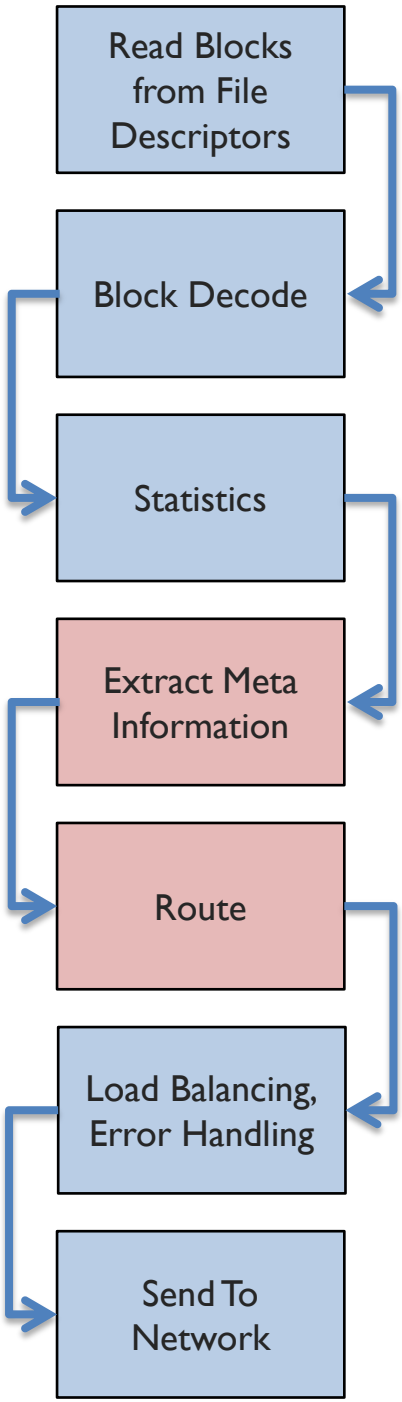

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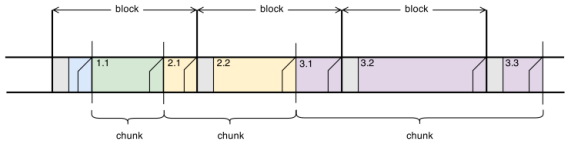
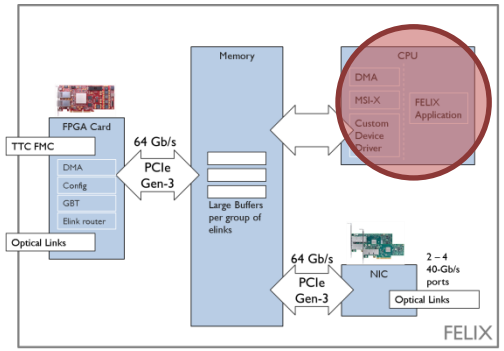


Count processed blocks, transfer rates, etc.

Metainformation, for example event ID, is extracted and matched against a routing table



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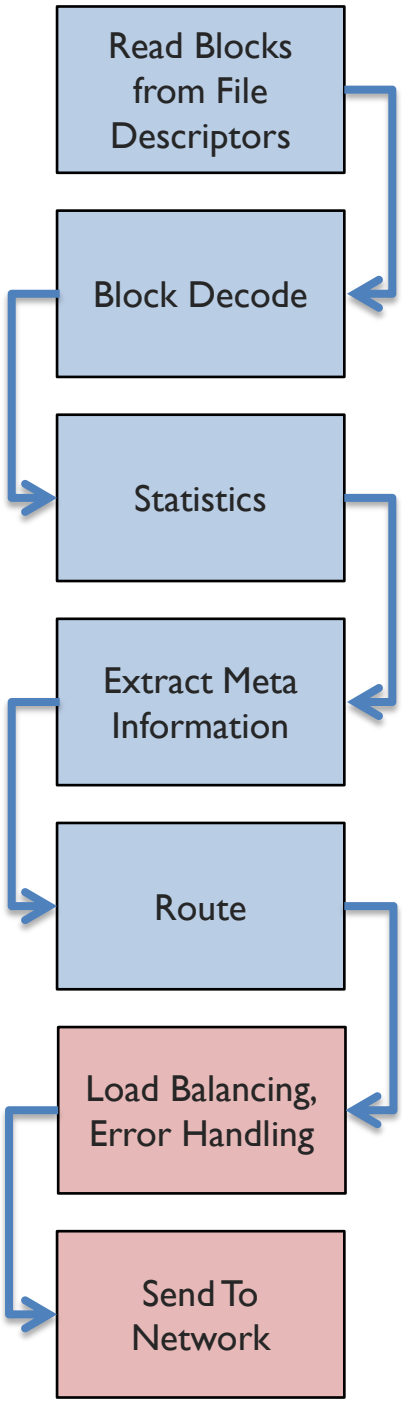

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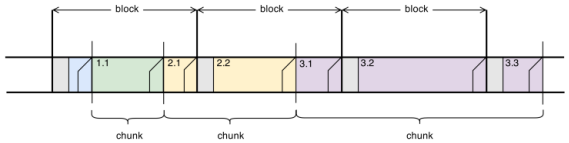
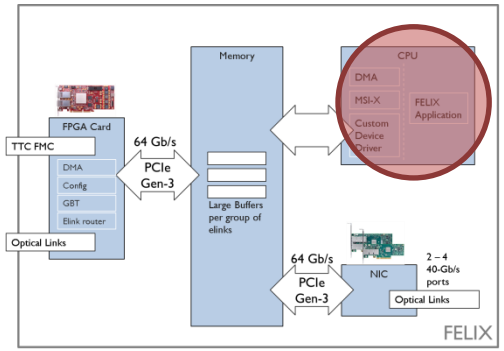


Count processed blocks, transfer rates, etc.

Metainformation, for example event ID, is extracted and matched against a routing table

Distribute load among multiple systems
Handle automatic failover in case of system failures

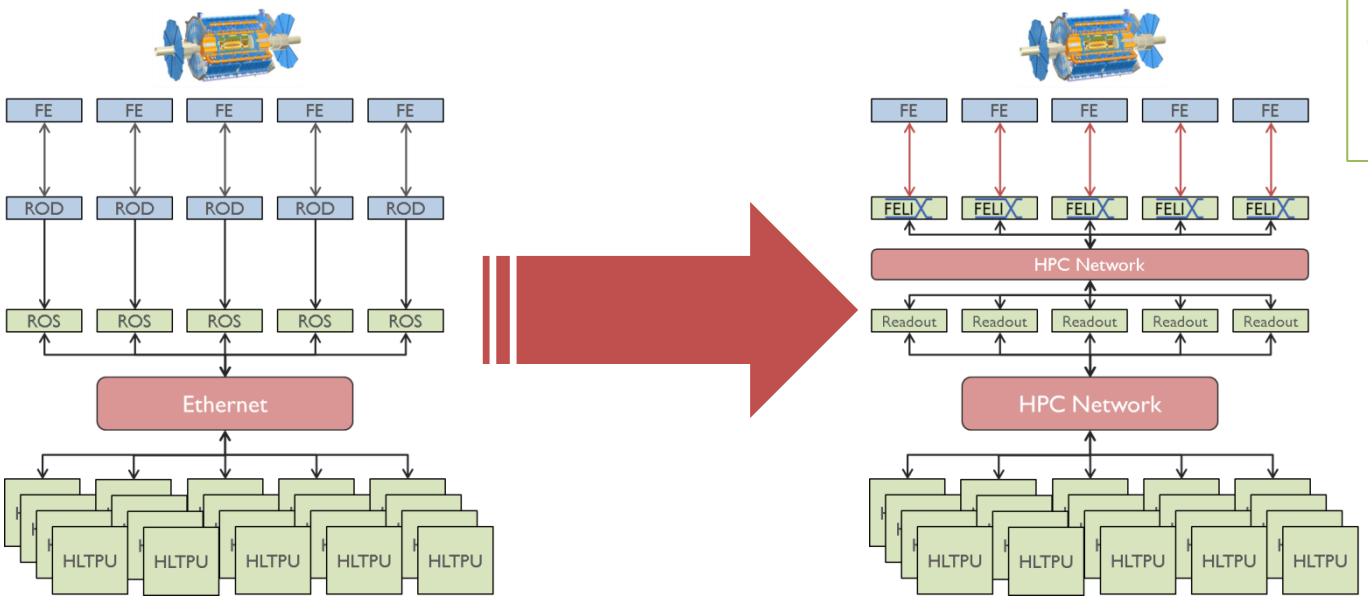


Summary

FELIX =

- general-purpose data-routing device
- connects ATLAS detector frontends to the ATLAS DAQ system
- load balancing, automatic failover, routing based on type of data (physics events, control, calibration, …)

Technology demonstrator currently under development



BACKUP

Examples for Functions

Forward
all incoming data of e-link 1
to
pc-daq-00.cern.ch

Send a complete e-link to a destination

Forward
Packets with data[5] == 0xAB
to
10.0.0.1:1234

Send only certain packets, marked by a flag in the data stream, to a certain destination

Forward
a random 10% sample of e-link 1
to
my-monitoring-server

Send a certain percentage of incoming data to a monitoring system

Forward
all incoming data of e-link 2
to any of
{pc-daq-00, pc-daq-01, pc-daq-02}

Load balancing: Distribute load among multiple systems

GBT Firmware