e2v

Linux Embedded applications in Machine Vision

Embedded Linux Conference – Europe (Grenoble)
October 15th, 2009

Pascal PELLET

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e2v presentation

Machine Vision

GigE Vision protocol

GiGE VISION

e2v GigE Vision IP

Conclusion & Evolution

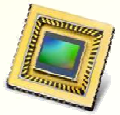
e2v presentation: Product Offer

Medical, Industrial & Emerging Imaging

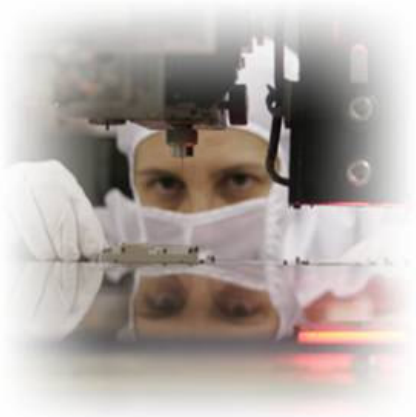
CCD sensors

Medical

CMOS sensors



Cameras



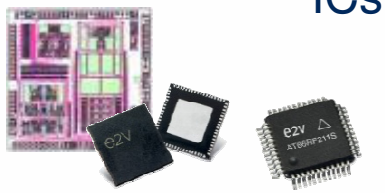
Space & Scientific Imaging

Space

Scientific Imaging

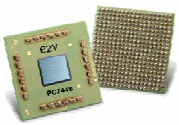
Mixed Signal ASICs

Sensor Signal conditioning ICs



Converters & Microprocessors

Broadband Data Converters



Assembly & Test services

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Fields of application

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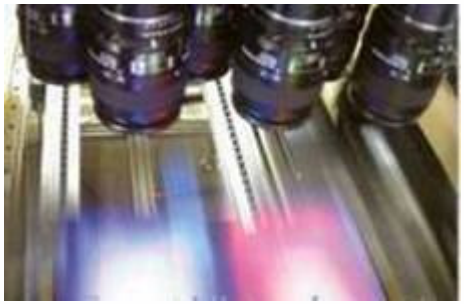
Aerospace	Defence	Automotive	Industrial Imaging



Telecom	Instrumentation	Medical	Industrial

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Machine Vision application

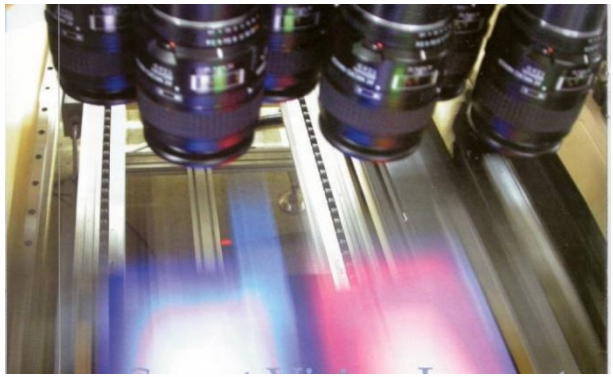
➜ For industrial market, e2v semiconductors is a world leader in development and manufacturing of camera for Machine Vision

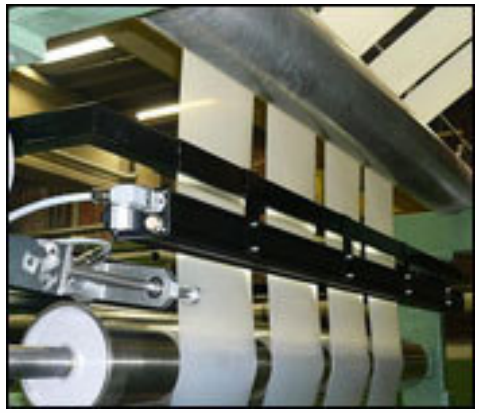
Machine Vision application

➜ System based on cameras and acquisition systems (frame grabber, PC, ...)

Machine Vision application

- Used in industry for
  - Foods (sort rice, fruit inspection,…)
  - Checking goods (web, papers, wood, glass, flat panel)





Machine Vision application

- e2v, with other Machine Vision companies, contributes to the development of industrial standards, including:
  - Camera Link
  - GigE Vision
  - GenIcam standard for software access

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Machine Vision

GigE Vision protocol

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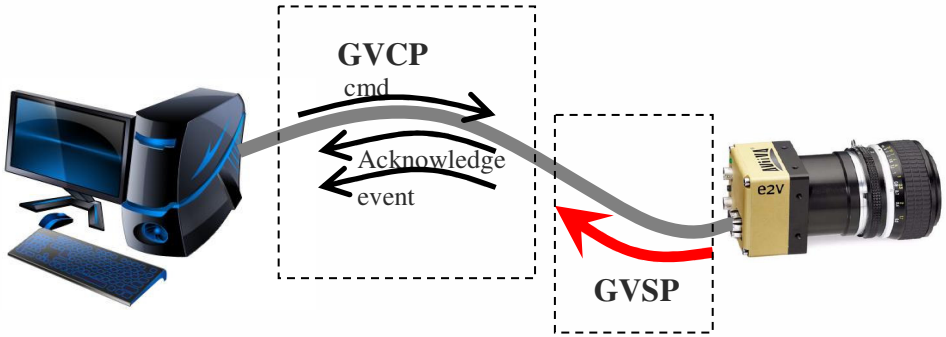
Conclusion & Evolution

GigE Vision protocol: Overview

- GigE Vision® is a camera interface standard developed, based on Ethernet protocol.
- Main benefits
  - fast image transfer: High bandwidth (1000 Mbps) allows large uncompressed images to be transferred quickly in real time
  - low cost standard cables over very long lengths (100 meters)
  - Data transfer up to Standard gigabit Ethernet hardware allows single/multiple camera connection to single/multiple computers
- This protocol is managed by AIA (Automated Imaging Association)
  - www.machinevisiononline.org
- e2v is a member of the Gige Vision development committee with other companies:
  - NI, Matrox, Pleora …

GigE Vision protocol: Overview

- GEV Protocol
  - GVCP: GigE Vision Control Protocol
  - GVSP: GigE Vision Stream Protocol
  - GEV is based on different phases
    - IP address allocation
    - Discovery
    - Connection
  - These protocols use UDP IPv4 as the transport Layer Protocol



- Device description
  - An xml file describes all the device capabilities (compliant with the GenICam specification)
    - One register corresponds to one feature
    - Understandable by any GenIcam PC software to monitor the camera

GigE Vision protocol:
GigE Vision Control Protocol (GVCP)

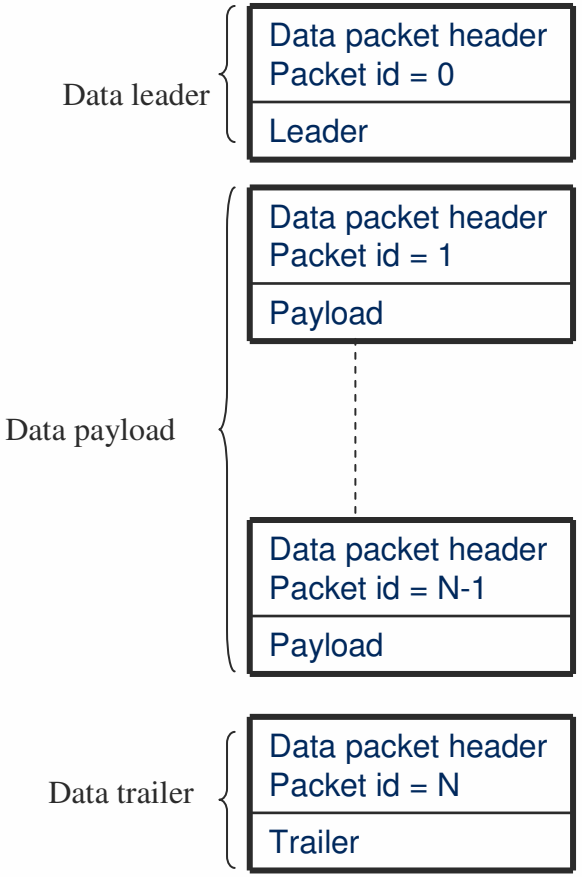
- GVCP is an application layer protocol relying on the UDP transport layer protocol
- GVCP provides a set of commands and acknowledges messages to be exchanged between GEV device(s) (camera) and a GEV application(s) (host)
  - Read/write Register
  - Read/Write Memory
  - Discovery
- Asynchronous Message can be sent by the device: event

- GVCP packet:

Layer	Size
IP header	20
UDP header	8
GVCP header	8
Max GVCP Payload	540
Total	**576**

GigE Vision protocol:
GigE Vision Stream Protocol (GVSP)

- GVSP is an application layer protocol relying on the UDP transport layer protocol.
- It allows an application to receive data blocks from a device.
- A data block is divided into 3 elements:
  - Data leader : advises the host of the beginning of the data block
  - Data Payload : data
  - Data Trailer : advises the user the end of the data block
- Payload types:
  - Image
  - Raw data
  - File
  - Chunk data
  - Device Specific



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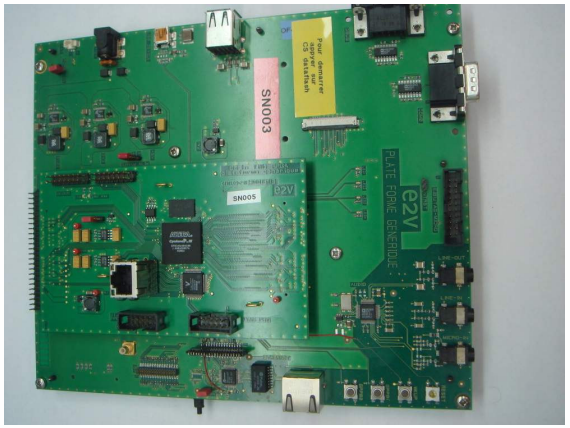
e2v GigE Vision IP:
e2v Generic platform

- In order to develop a camera supporting GigE Vision, e2v has developed a generic platform based on:
  - ARM processor (Atmel AT91SAM9263)
  - Linux v2.6.24

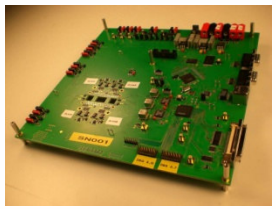


e2v GigE Vision IP: Base bricks to products

- ➜ New base bricks: ⟹ ➜ New products:
  - ➜ Camera link IP ⟹ ➜ Camera Link LineScan Camera:
    - ➜ AviivA EM2CL – AviivA EM4CL
      - ➜ 160 Mpixels/sec
      - ➜ Mono8-12bit

  - ➜ GigE Vision IP ⟹ ➜ GigE Vision LineScan Camera :
    - ➜ AviivA EM1GE
      - ➜ 120 MPixels/sec
      - ➜ Mono8/12bit

  - ➜ Characterization IP ⟹ ➜ Characterization boards (internal use)
    - ➜ CCD and CMOS Imaging sensors
    - ➜ ADC …



e2v GigE Vision IP: fixe issues

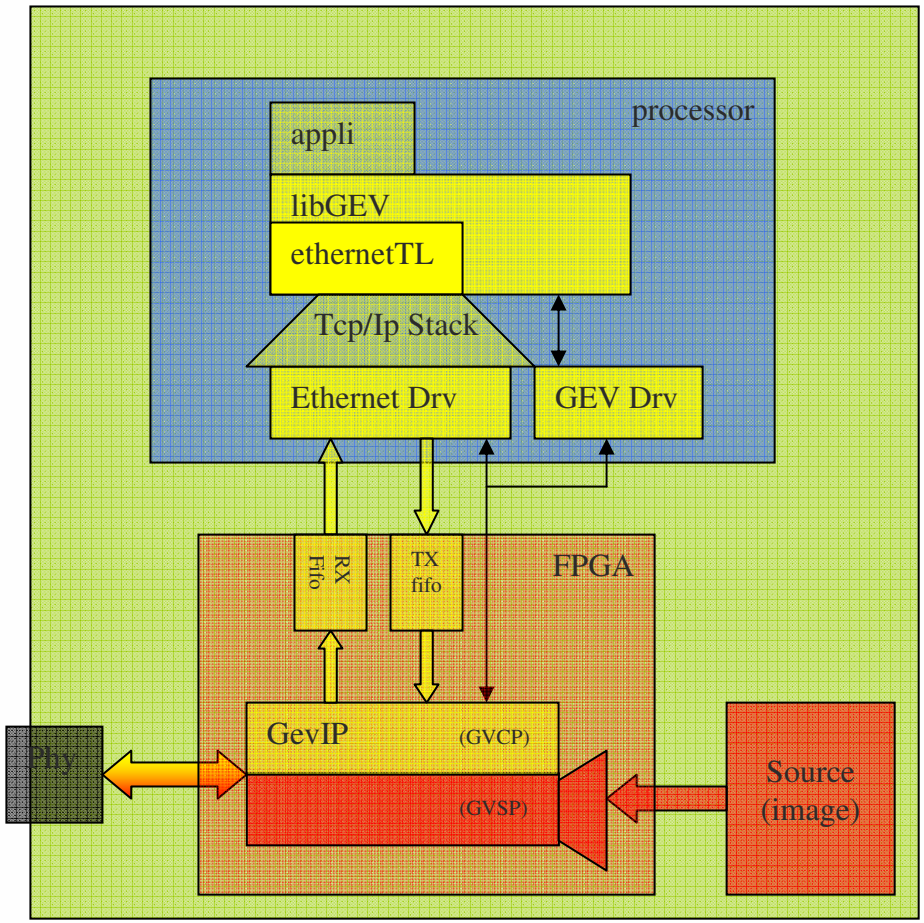
- e2v fixed issues for its products:
  - Upgradable
  - Reliability
  - Reduce the development time

e2v GigE Vision IP: Benefits

- What does this platform bring for e2v products
  - Project
    - Re-use
    - Cost Saving
    - Reliability / Improvement
  - Development flow
    - Support and knowledge
    - Validation and testability
    - C++ (abstraction, coding efficiency)
  - Linux services
    - TCP/IP Stack
    - PPP
    - File system management
    - ARP
    - Multi thread

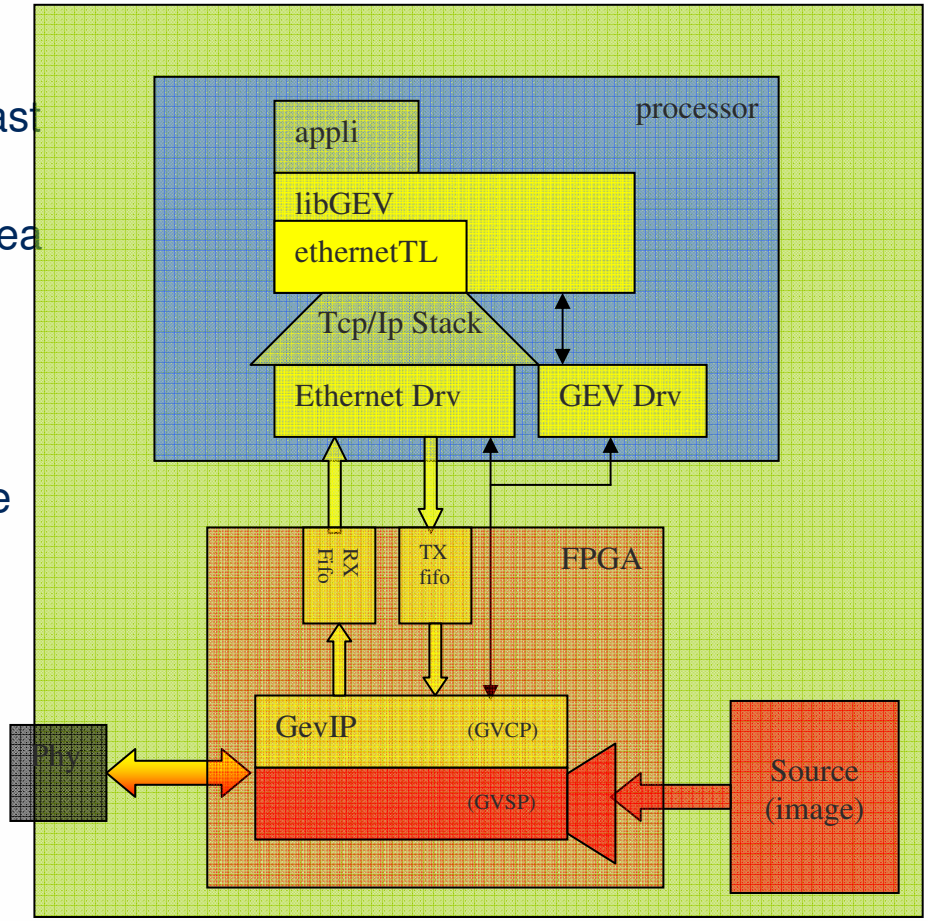
e2v GigE Vision IP Architecture

- e2v develops a GigE Vision IP based on this generic platform and a FPGA



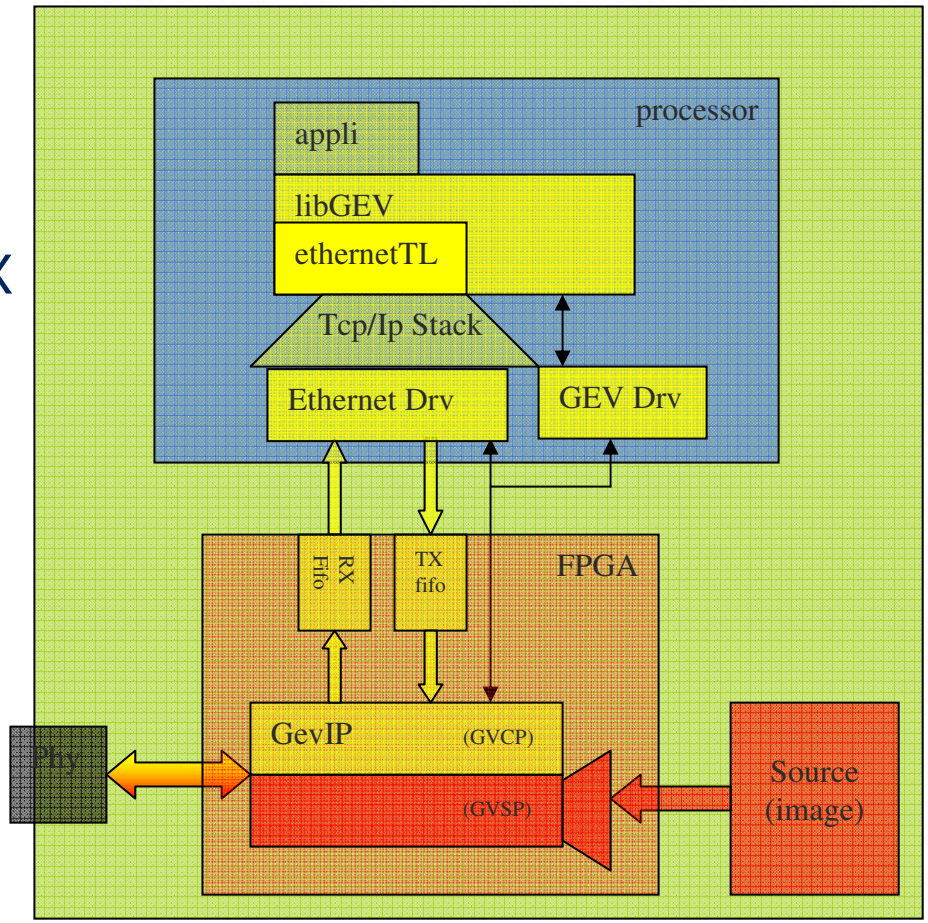
e2v GigE Vision IP: FPGA IP

- Interfaces with the PHY
- Manages Ethernet packet
  - Filter with MAC Address, broadcast packets
  - Offers RX,TX FIFOs, registers area to the processor
- FPGA Interruption : advises the processor that Ethernet packets are available
- RX FIFO: Ethernet packets sent by the host
- TX FIFO: Ethernet packets sent to the host
- Manages GVSP packet (streaming)



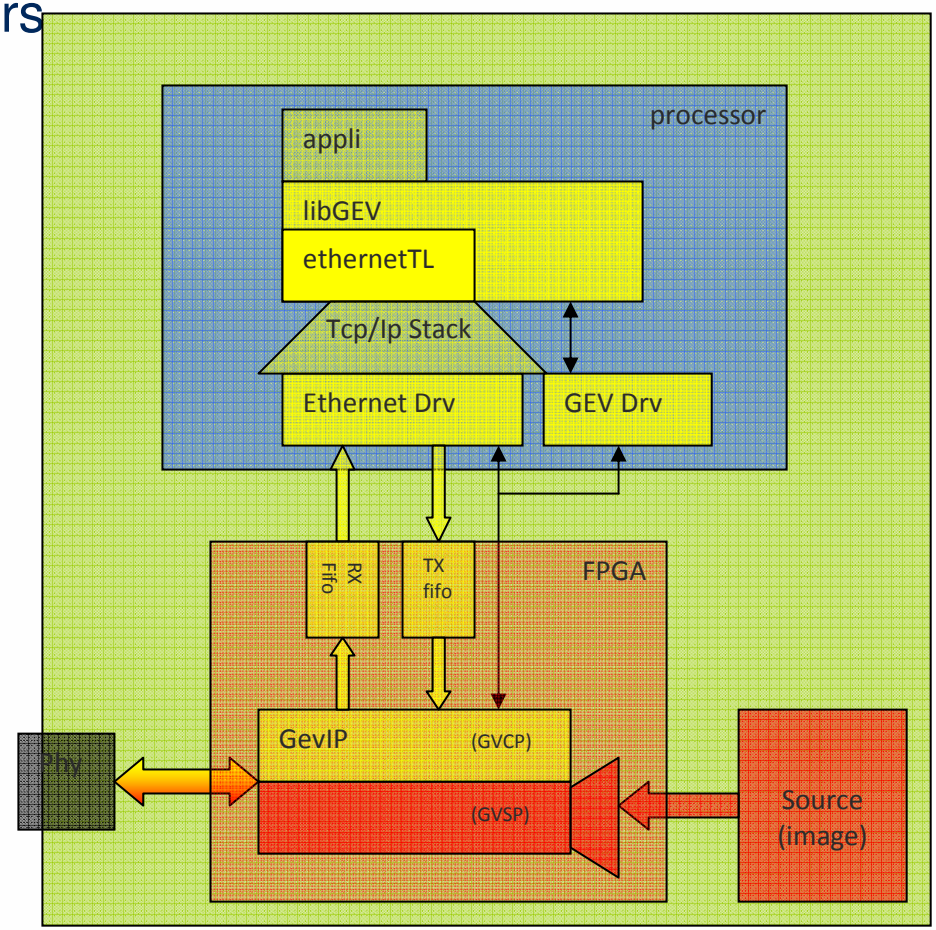
e2v GigE Vision IP: Ethernet driver

- ➜ Configures the PHY
- ➜ Interfaces with the FPGA
- ➜ Configures the FPGA (Mac Address …)
- ➜ Copies packets from FPGA RX FIFO to the TCP/IP stack
- ➜ Copies packets from TCP/IP stack to the TX FIFO



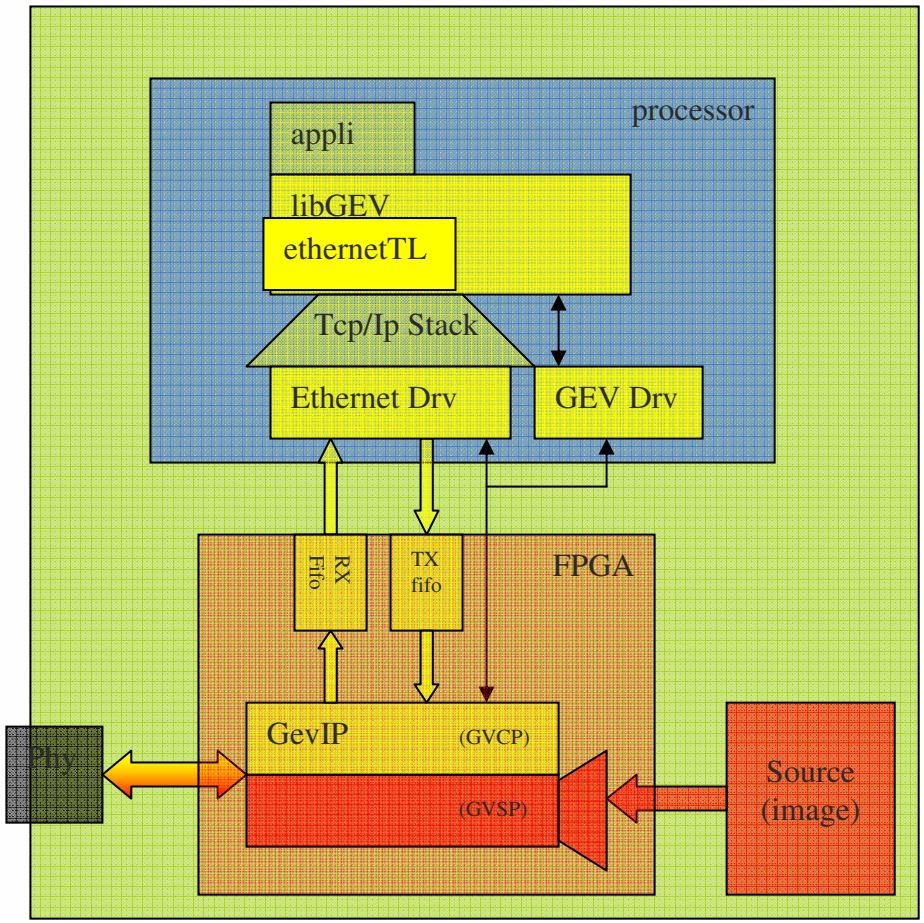
e2v GigE Vision IP: GEV driver

➜ Access to FPGA GEV Registers



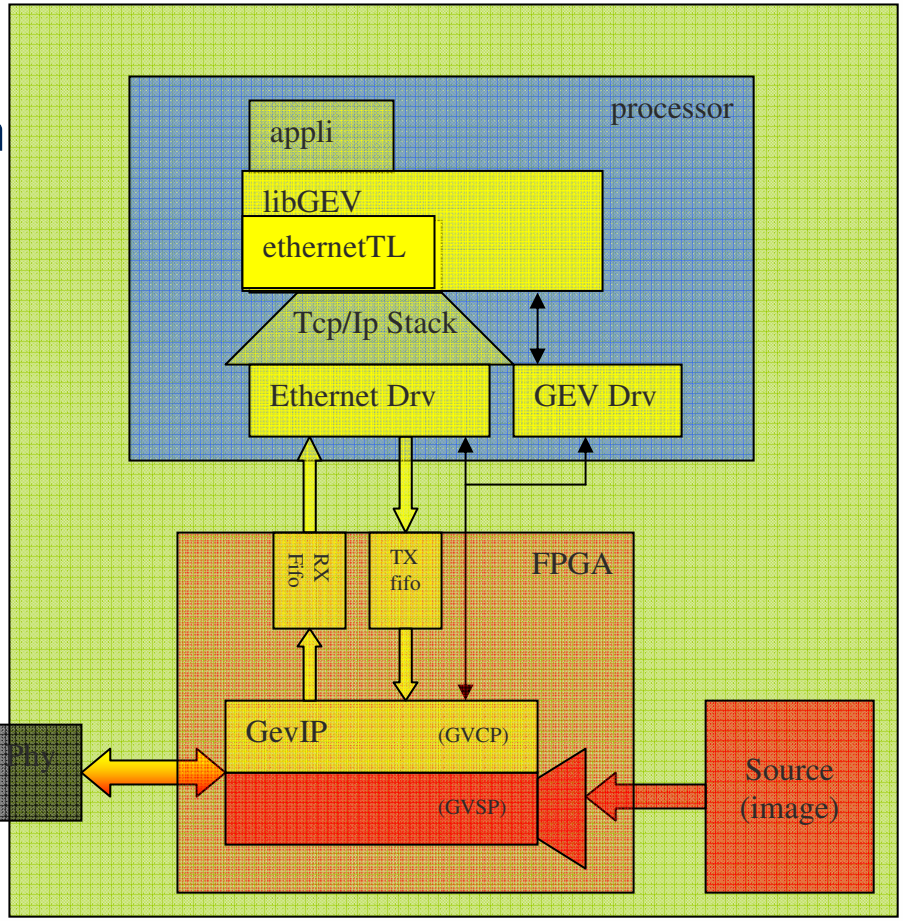
e2v GigE Vision IP: EthernetTL library

- ➜ Loads the FPGA
- ➜ Mounts the Ethernet driver
- ➜ Sets Mac address



e2v GigE Vision IP:
GigE Vision Library (libGEV)

- ➜ Offers all GigE Vision based features
- ➜ Mounts the Ethernet connection (through ethernetTL)
- ➜ IP address Allocation
- ➜ Discovery
- ➜ Read/Write memory/register
- ➜ GEV registers configuration



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Conclusion & Evolution

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Performance

- For the control, the gigabit per second is not required.
  - Max speed: 30Mbit/sec
  - To improve speed:
    - Use DMA to read/write into FPGA FIFOs

- For the streaming the gigabit is required
  - Max transmission speed 984Mbit/sec

Conclusion & Evolution
Performance

- Software Interoperability
  - With the main GEV application software
    - National Instrument
    - Matrox
  - GigE Vision compliant
- Reliability
  - Memory allocation
  - Temperature

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- Other GigE Vision applications:
  - Medical: X-ray application

  - Evaluation kit/characterization board for image sensors

  - Spectrometry :Swifts (Minalogic project)

  - Smart camera (no real time processing)
    - Gain control
    - Light control

Conclusion & Evolution

- Next: 10 gigabit Ethernet
  - Optical fiber
  - Copper wire

- Power Over Ethernet
  - video surveillance

Questions & Answers

Any Question ???