Jumping Hurdles

High Expectations in a Low Power Environment

Christopher Fadeley
Software Engineering Manager
EIZO Rugged Solutions

Biggest Challenges

- Embedded/Rugged Environment
  - High performance expectations
  - Cooling in conduction cooled environments
  - Bandwidth limitations
  - Customization!

Desktop vs Embedded Environment

- Power Consumption of GPU

Environment	Form Factor	Max Power Usage
Desktop	PCI-e	150-250W
Embedded	VPX	40-100W
Embedded	XMC	20-45W

- Clocks

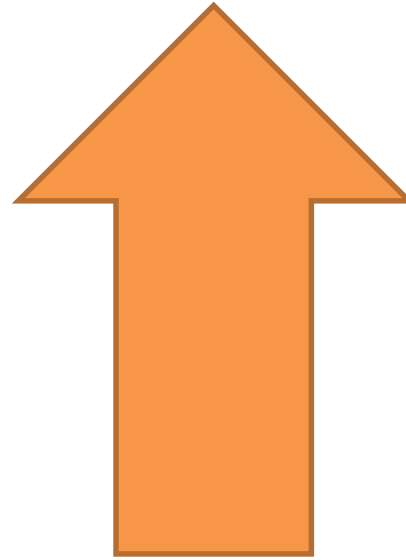| Environment	Form Factor	GPU Clock Speed
Desktop	PCI-e	1000-1500Mhz
Embedded	VPX	600-1000Mhz
Embedded	XMC	400-600Mhz

Increasing Throughput

- Only options:
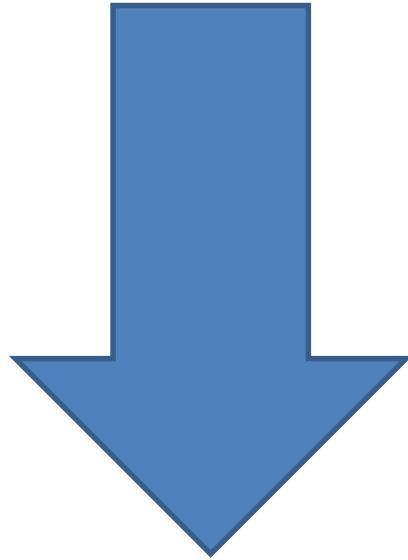
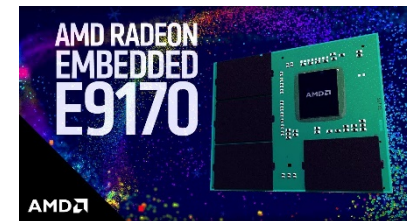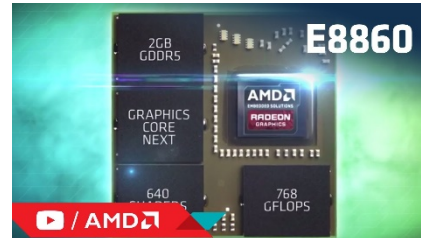Thermal Management   Increase Performance per Watt

Handling Heat

- Conflict: power requirements vs thermal management.
- Heatsink design
  - Composition of Material
  - Thermal efficiency
- Schematic and Layout Design
  - Part selection
  - Placement of parts
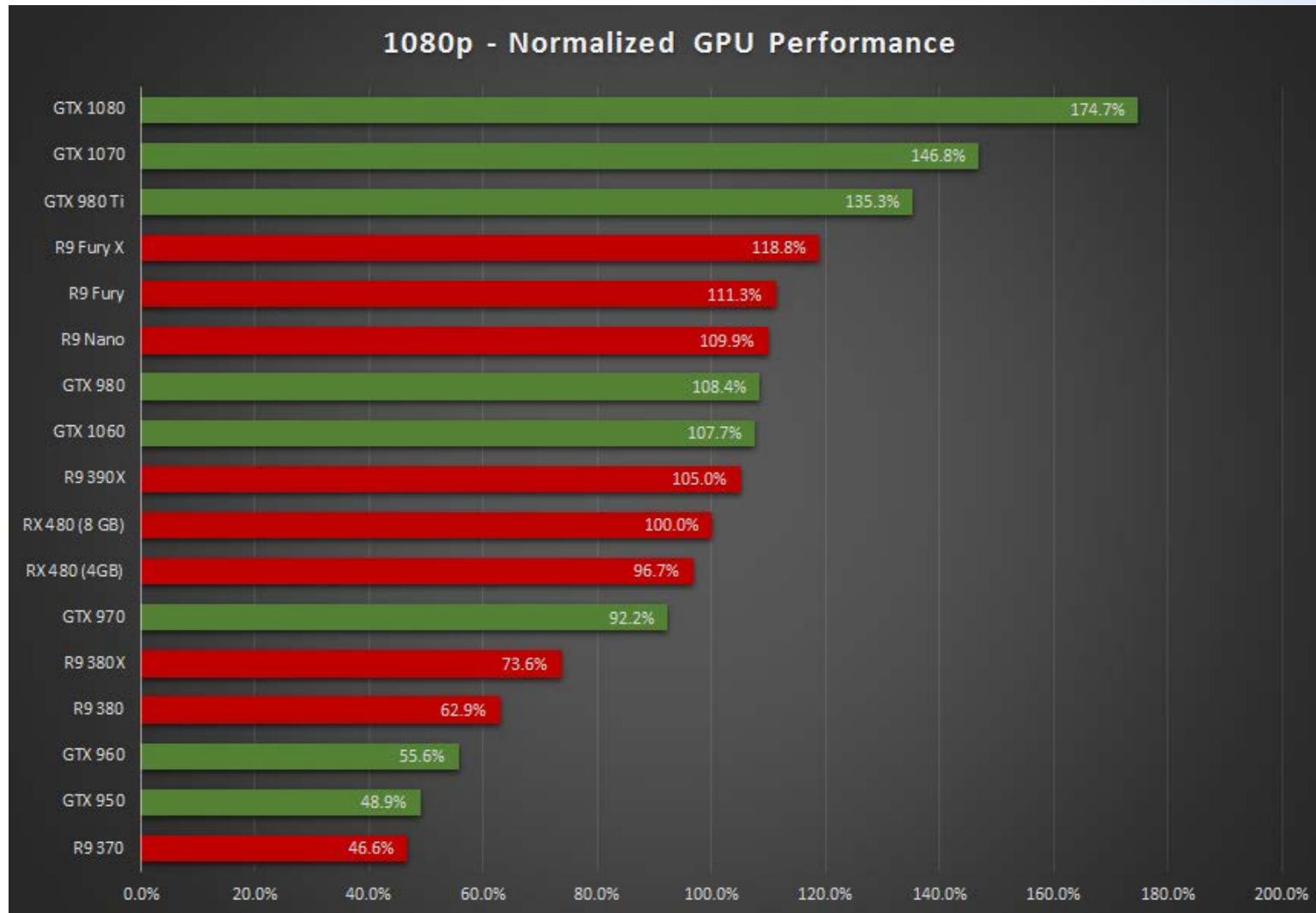 - Heat efficiency in layout

Performance

- Latest Technologies
- Customizations
  - BIOS
  - Software
    - Clocks
    - Alarm Temperatures

Performance

https://www.reddit.com/r/Amd/comments/4tshf9/i_graphed_normalized_benchmark_data_as_well_as/

Bandwidth

- Customers expect to be able to handle multiple high definition video feeds.
  - Raw and encoded
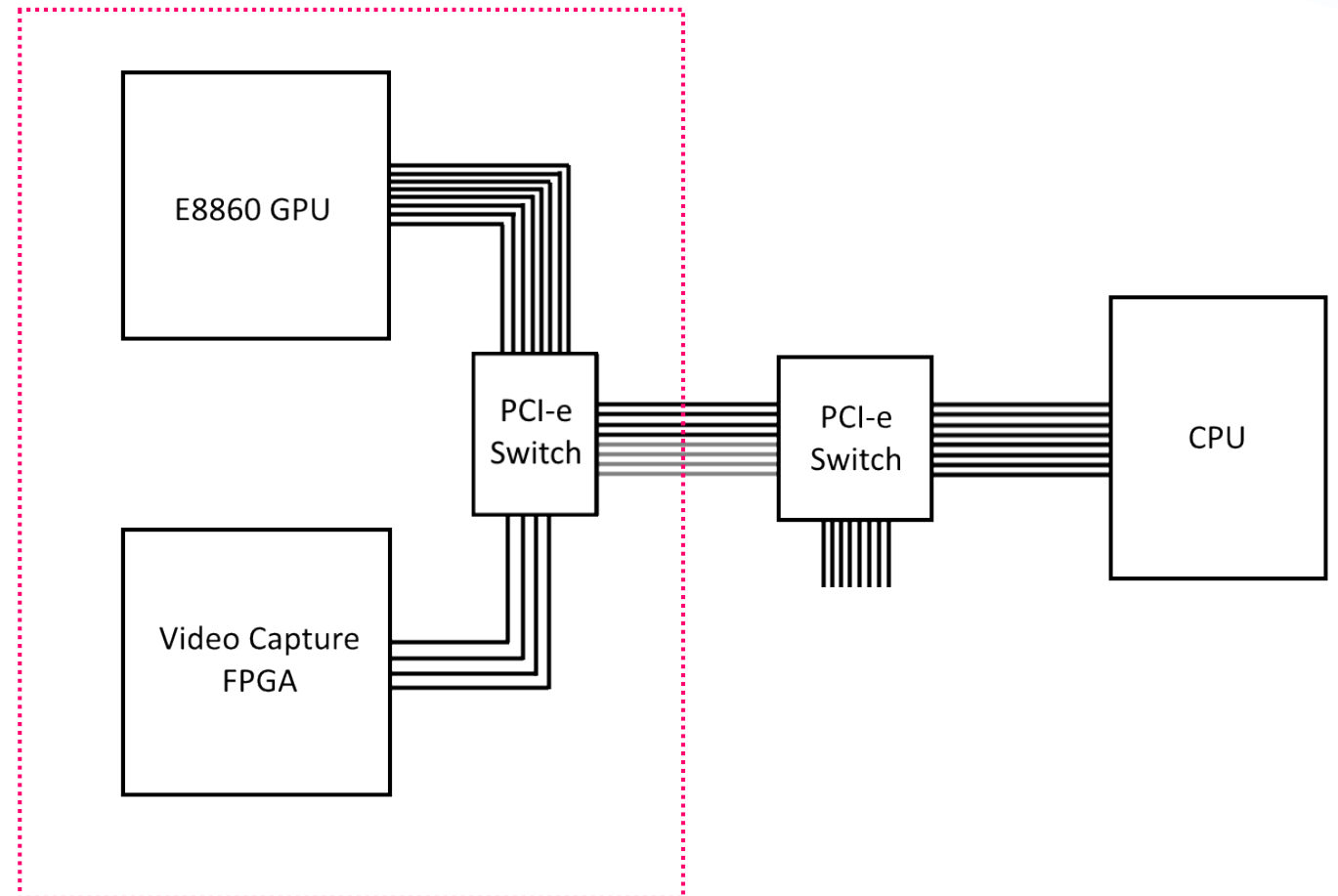 - Limited network bandwidth and/or stability
  - PCI-e bandwidth

System Resource Bandwidth

- PCI-e lane availability

Environment	PCI-e Lanes	
Desktop	16x	8x + 8x
Embedded	8x	4x + 4x

System Resource Bandwidth

- PCI-e Generation Support
  - Support newer generations as video data becomes larger

PCI-e Generation	1x Lanes	4x Lanes	8x Lanes	16x Lanes
1.0	250 MB/s	1 GB/s	2 GB/s	4 GB/s
2.0	500 MB/s	2 GB/s	4 GB/s	8 GB/s
3.0	984.6 MB/s	3.94 GB/s	7.9 GB/s	15.8 GB/s
4.0	1969 MB/s	7.9 GB/s	15.8 GB/s	31.5 GB/s

Video Size	1x Captures	2x Captures	4x Captures
720p60	211 MB/s	422MB/s	844 MB/s
1080p30	237.5 MB/s	475 MB/s	950 MB/s
1080p60	475 MB/s	950 MB/s	1.9 GB/s
2160p60	2 GB/s	4 GB/s	8 GB/s

System Resource Bandwidth

- PCI-e Generation Support
  - Support newer generations as video data becomes larger

PCI-e Generation	1x Lanes	4x Lanes	8x Lanes	16x Lanes
1.0	250 MB/s	1 GB/s	2 GB/s	4 GB/s
2.0	500 MB/s	2 GB/s	4 GB/s	8 GB/s
3.0	984.6 MB/s	3.94 GB/s	7.9 GB/s	15.8 GB/s
4.0	1969 MB/s	7.9 GB/s	15.8 GB/s	31.5 GB/s

Video Size	1x Captures	2x Captures	4x Captures
720p60	211 MB/s	422MB/s	844 MB/s
1080p30	237.5 MB/s	475 MB/s	950 MB/s
1080p60	475 MB/s	950 MB/s	1.9 GB/s
2160p60	2 GB/s	4 GB/s	8 GB/s

System Resource Bandwidth

- PCI-e Generation Support
  - Support newer generations as video data becomes larger

PCI-e Generation	1x Lanes	4x Lanes	8x Lanes	16x Lanes
1.0	250 MB/s	1 GB/s	2 GB/s	4 GB/s
2.0	500 MB/s	2 GB/s	4 GB/s	8 GB/s
3.0	984.6 MB/s	3.94 GB/s	7.9 GB/s	15.8 GB/s
4.0	1969 MB/s	7.9 GB/s	15.8 GB/s	31.5 GB/s

| Video Size	1x Captures	2x Captures	4x Captures
720p60	211 MB/s	422MB/s	844 MB/s
1080p30	237.5 MB/s	475 MB/s	950 MB/s
1080p60	475 MB/s	950 MB/s	1.9 GB/s
2160p60	2 GB/s	4 GB/s	8 GB/s

System Resource Bandwidth

- ## CPU Load
  - ### CPU may have to perform memcpys of DMA-ed data
  - ### Additional CPU tasks:
    - Additional programs
    - Encoding/Recording

- ## Direct to GPU Memory
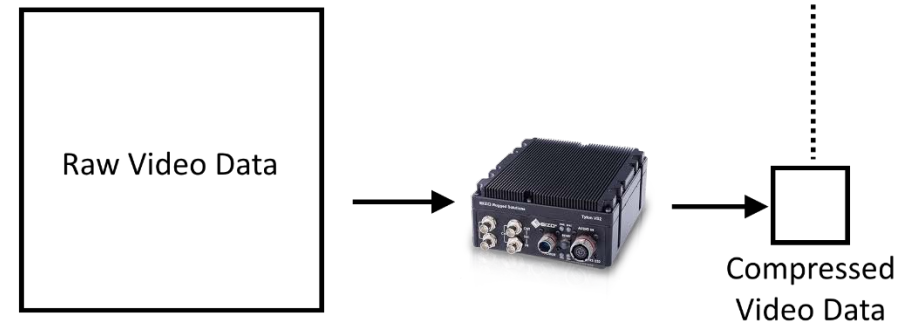
Network Bandwidth

- ## Network Bandwidth
  - <10Mb/s total available
  - Even less dedicated per stream
- ## Raw 1920x1080@60fps SDI
  - 1800 Mb/s
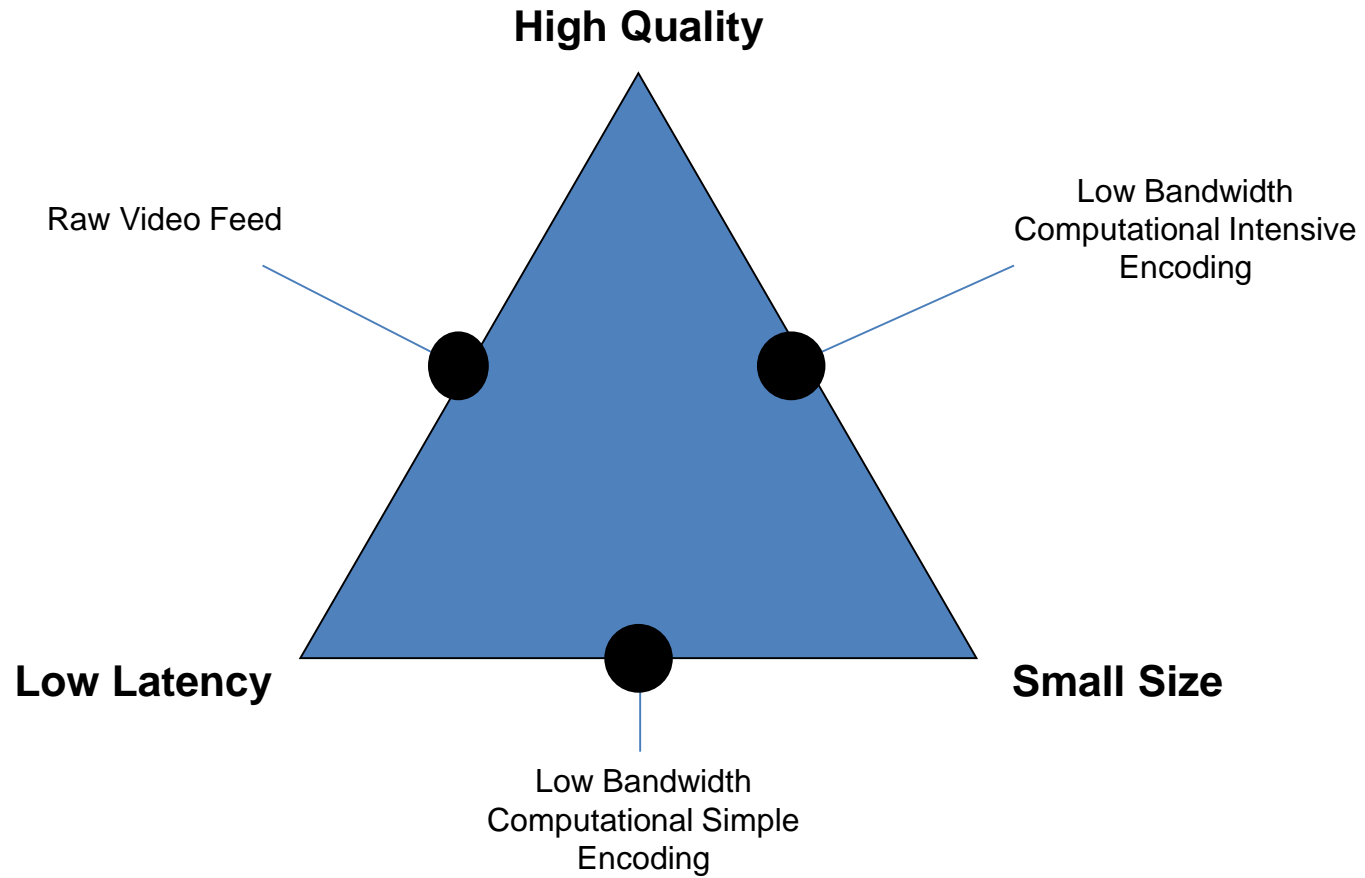
Raw Video Data

Compressed
Video Data
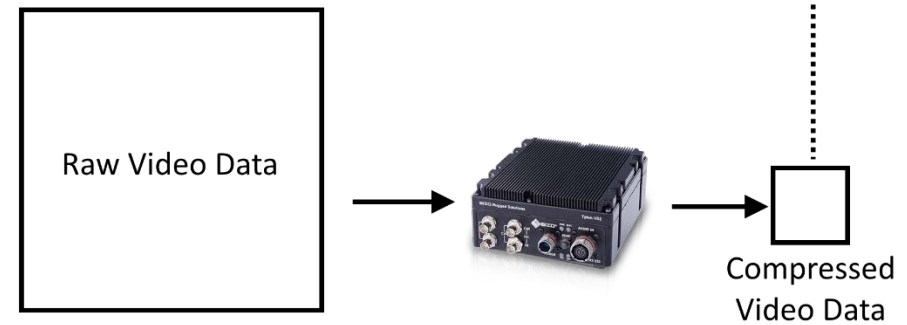
Network Bandwidth

- Latest Compression Technology
  - H.265/HEVC
- Advanced Chroma Subsampling
- Hardware Resizer
- Framerate Dropping
- Motion Filters

Raw Video Data
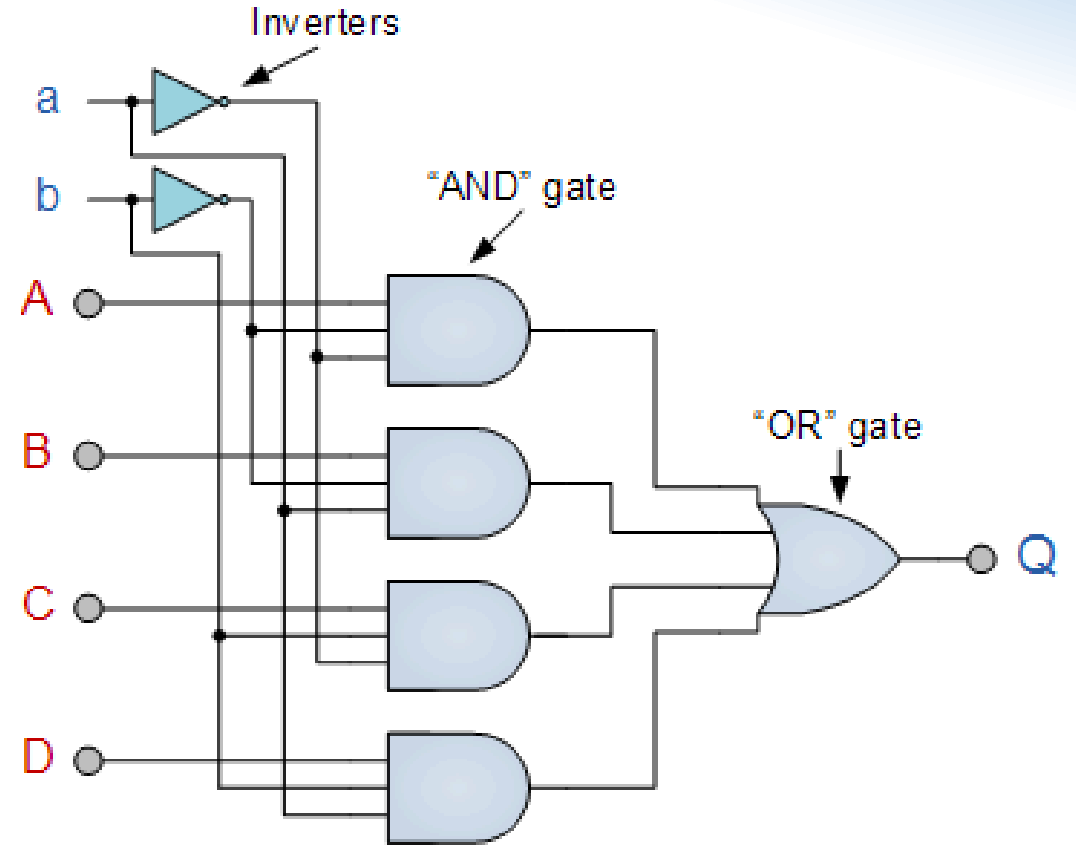
Compressed Video Data

Network Bandwidth

Customer Relationship

- Work with end customers and integrators before and after purchase.
- Business relationships are as important as engineering proficiency.

Customer Needs: Combining Products

- Create building blocks
  - Encoders
  - Raw Video Capture Cards
  - GPUs

Customer Needs: Combining Products
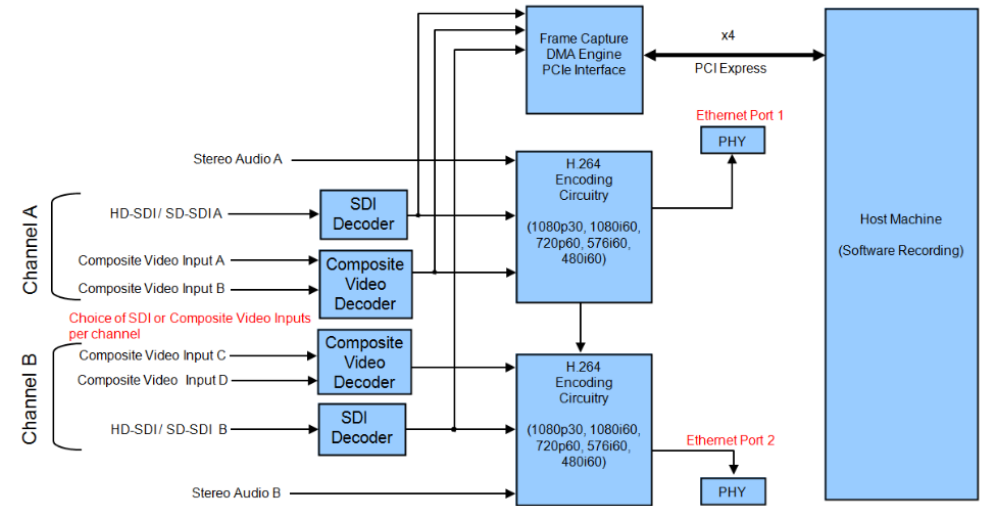
- Merging Hardware:
  - Encoder + Raw Capture

SDI/TV Encoder

+

Raw
Video
Capture

=

SDI/TV Encoder
+
Raw Video Capture

Customer Needs: Combining Products

- ## Merging Hardware:
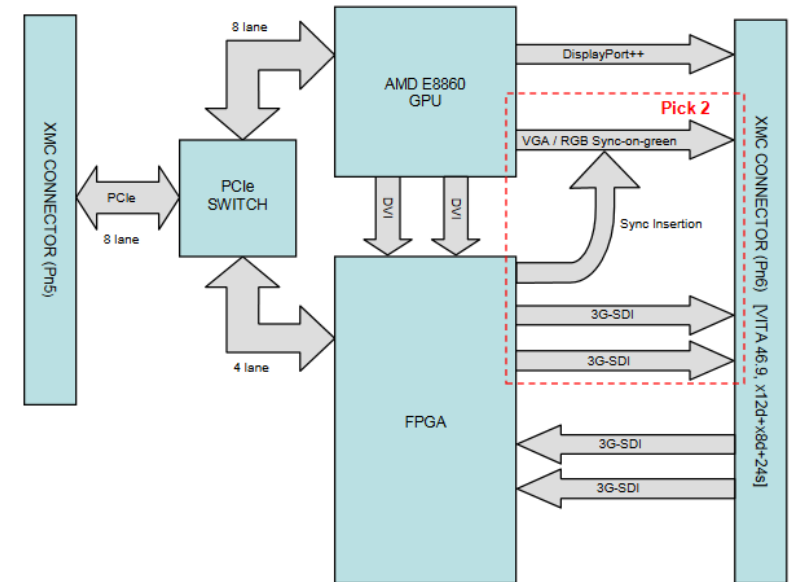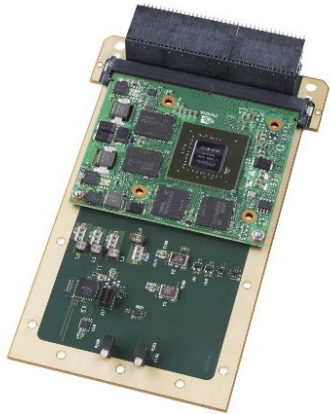 - ### Raw Capture + GPU

GPU

Raw Video Capture

GPU
+
Raw Video Capture

Customer Needs: Combining Products

- Merging Hardware:
  - SBC + GPU

VPX Card w/ GPU

SBC

VPX Card w/ GPU
&
XMC Site for SBC

Customer Needs: Combining Products

- Challenges
  - Additional functionality == More heat
  - Shared PCI-e bus
  - Limited size
  - Software Support

Customer I/O Needs

- Hundreds of different inputs and output combinations

- Inputs:
  - Computer
    - DisplayPort
    - VGA
    - HDMI
    - DVI
  - Camera Source
    - SD/HD/3G/6G - SDI
    - NTSC
    - PAL
    - SECAM
    - STANAG Variants
    - ARINC 818
    - HDMI

- Outputs
  - To a monitor
    - DisplayPort
    - VGA
    - HDMI
    - DVI
    - SD/HD/3G/6G - SDI
    - NTSC
    - PAL
    - SECAM
    - STANAG Variants
    - ARINC 818

- Platform
  - 3U-VPX
  - 6U-VPX
  - XMC
  - PCI-e
  - Conduction Cooled
  - Front I/O
  - Rear I/O

Customer I/O Needs

- Hard Truth:
  - **There is no possible way to support everything on a single board**
  - But, there is an art of supporting immediate needs while not preventing potential future needs

Customer I/O Needs

- Modularize Externally
  - Dongles
  - Converters
- Modularize Internally
  - Move towards FPGAs instead of ICs

Customer I/O Needs

- Mux & Modularize Connectors
  - BNC connectors used for both TV & SDI
  - Connectors isolated from processing

Thank You