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Medical Applications using PCI Express

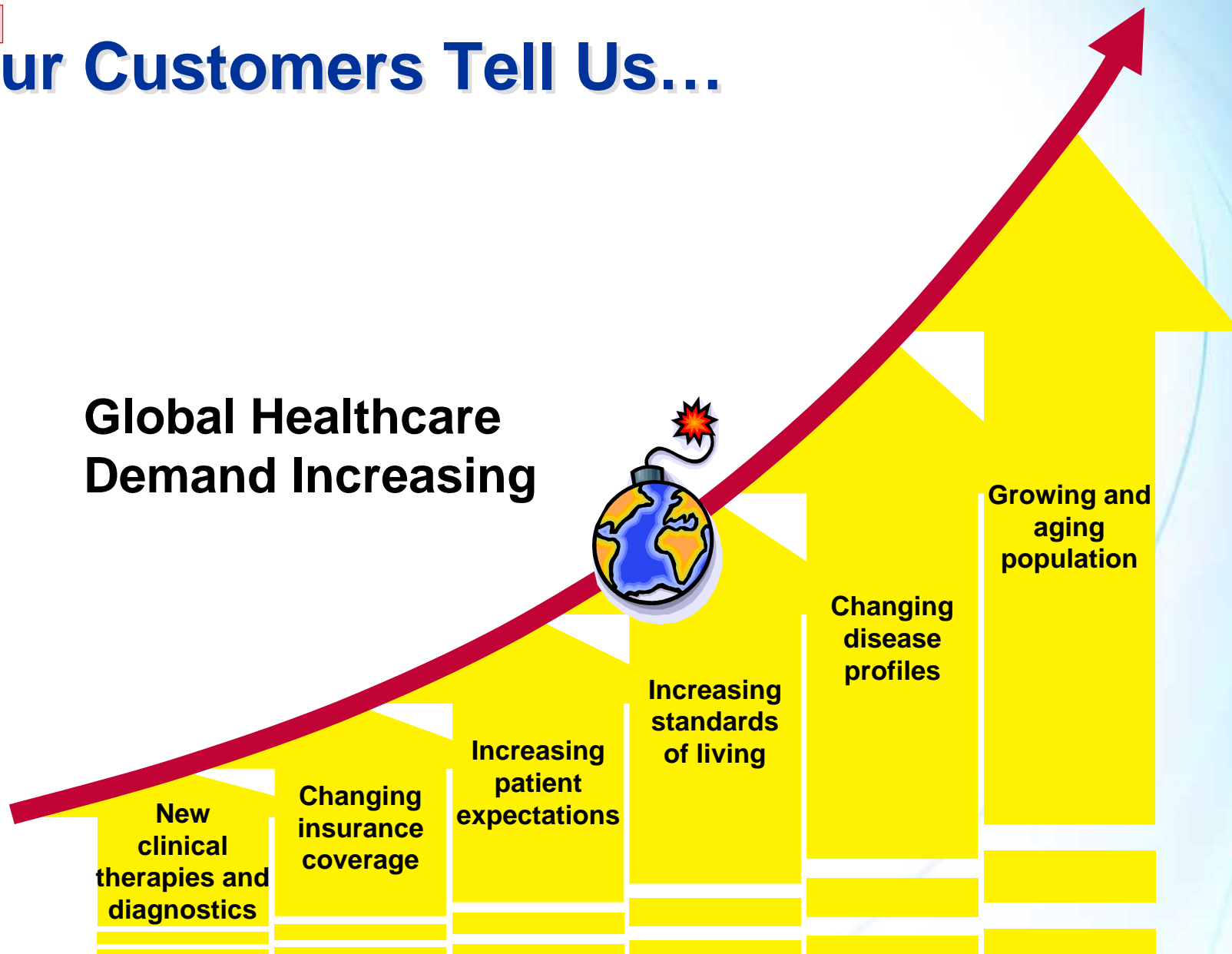


Agenda

- Trends in medical applications
- Role of PCI Express
- Altera® PCI Express solution
- PCI Express demo

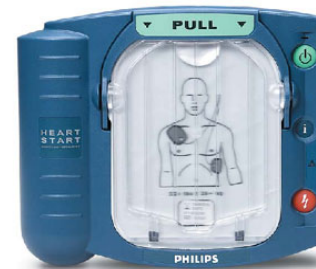
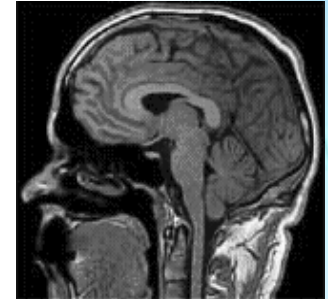
Our Customers Tell Us...

Global Healthcare Demand Increasing



Medical Sub-Segments

- Diagnostic imaging
 - Ultrasound (US)
 - Computed tomography (CT)
 - Magnetic resonance imaging (MRI)
 - Positron emission tomography (PET)
 - X-ray
- Electro-medical
 - Patient monitoring
 - Ventilation and life support
 - Anesthesia
- Cardiac rhythm management (CRM)
 - Automatic external defibrillators (AED)
 - Pacing systems
 - Implantable cardiac defibrillators (ICD)
- Other medical lab equipment
 - Scientific and lab instrumentation
 - Radiation



AED



Blood Analysis Centrifuge

Diagnostic Imaging Trends

Modality	Trend
All	1. Trend towards digital imaging - higher resolution and 3-D imaging 2. Increased amount of high-speed filtering
	Trend towards serial backplanes
	Portable imaging has potential to reach wider customer base
CT	Single slice to multi-slice
MRI	Higher Tesla (T) based systems
Ultrasound	Higher growth rates in developing nations due to lower system costs
X-ray	Higher growth rates in developing nations due to lower system costs
CT and PET	Evolution of combined modalities
Nuclear/PET	The fastest growing modality – '03-'08 compound annual growth rate (CAGR) of 12%

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Trends in Medical Systems



Our Customers Tell Us...

Healthcare Providers Driving Towards:

**Individualized
patient focus**

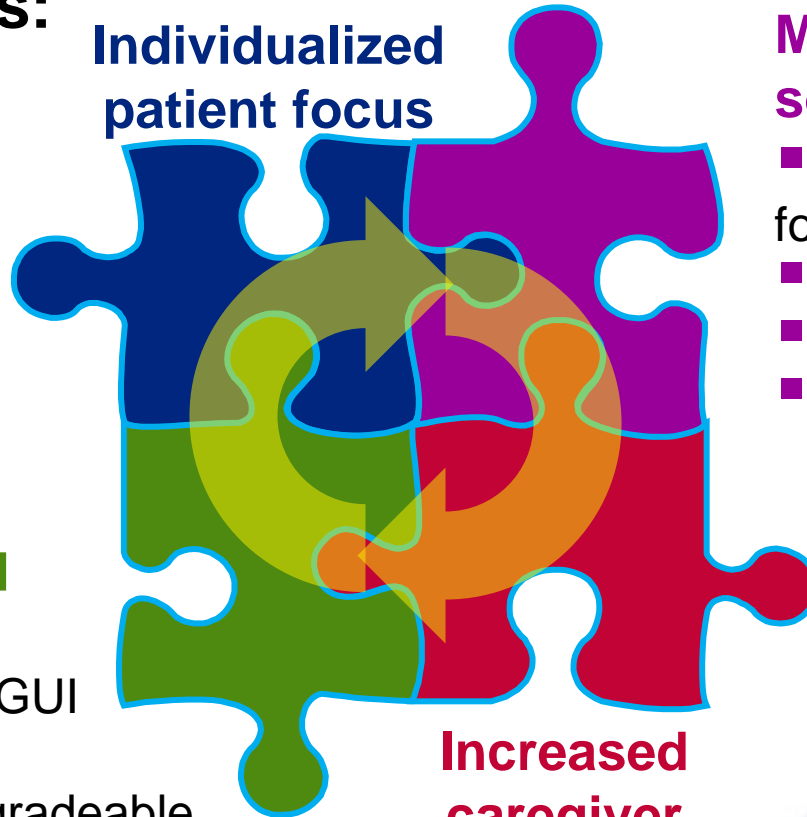
**Medical OEM
solutions**

- Handheld and portable form factors
- Flexible
- Modular
- Cost-effective

**Medical OEM
solutions**

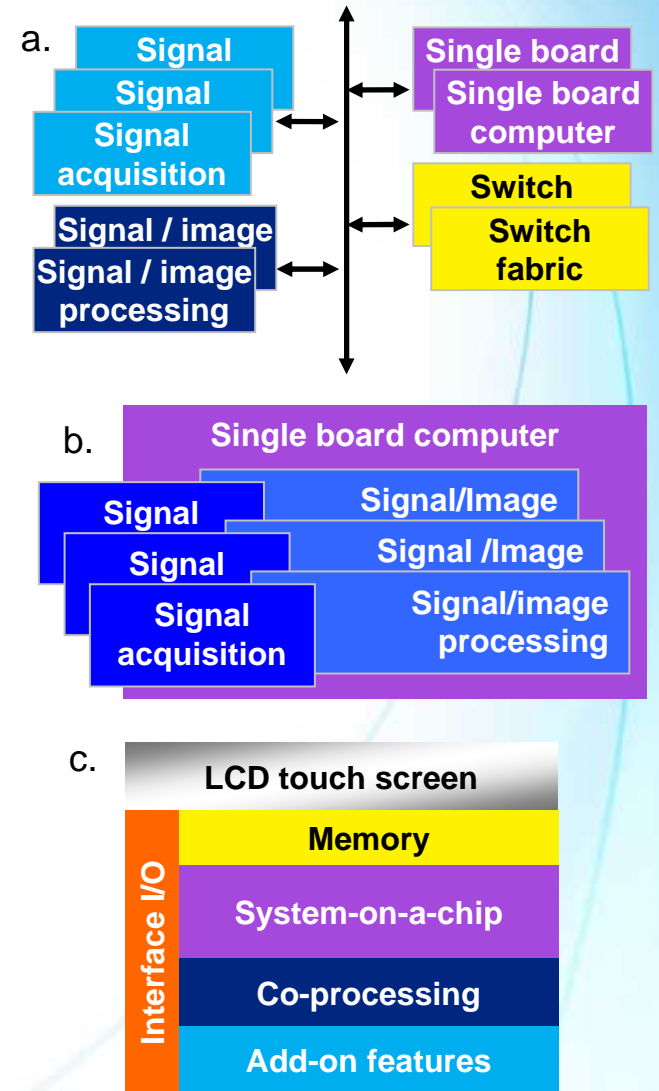
- Easy-to-use GUI
- Connectivity
- Software upgradeable

**Increased
caregiver
productivity**



Product Development Trends

- Market dynamics drive focus on differentiating via software and firmware
- Common hardware architectures are emerging:
 - a. Chassis-based, premium systems
 - b. Modular-based, mid-range systems
 - c. Handheld, value systems
- Architectural building blocks becoming standardized

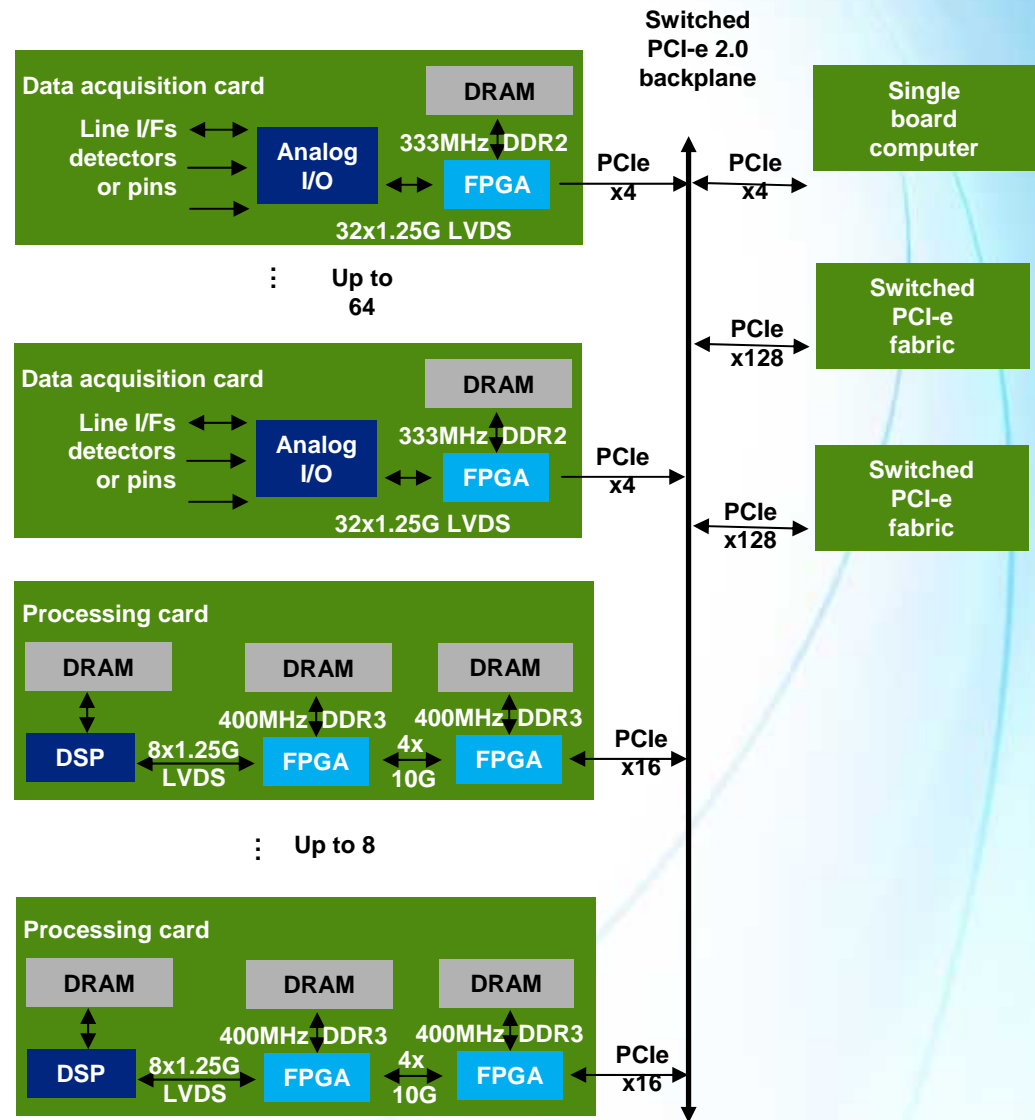


Three Emerging Platforms

- Chassis
 - Leveraging PCIe/GbE for backplane interconnect
 - High-end medical imaging
- Modular
 - Leveraging **SBCs for software convenience and COTS hardware**
 - Patient monitoring, ultrasound, x-ray
- Handheld
 - Leveraging system-on-a-programmable-chip (SOPC) FPGAs
 - Low-end patient monitoring/ultrasound

T&M Chassis System in 2008

- Asymmetric data flow
 - Scalable to smaller chassis
- Applications:
 - High-end medical imaging
 - CT, MR, PET
- Devices:
 - Acquisition: Cyclone® III FPGAs
 - Processing: Stratix® III FPGAs
 - Configuration and BIST: MAX® III CPLDs
- Competition:
 - FPGAs, ASICs, digital signal processing (DSP) devices



T&M Modular System in 2008

- Stackable modules

- Applications:

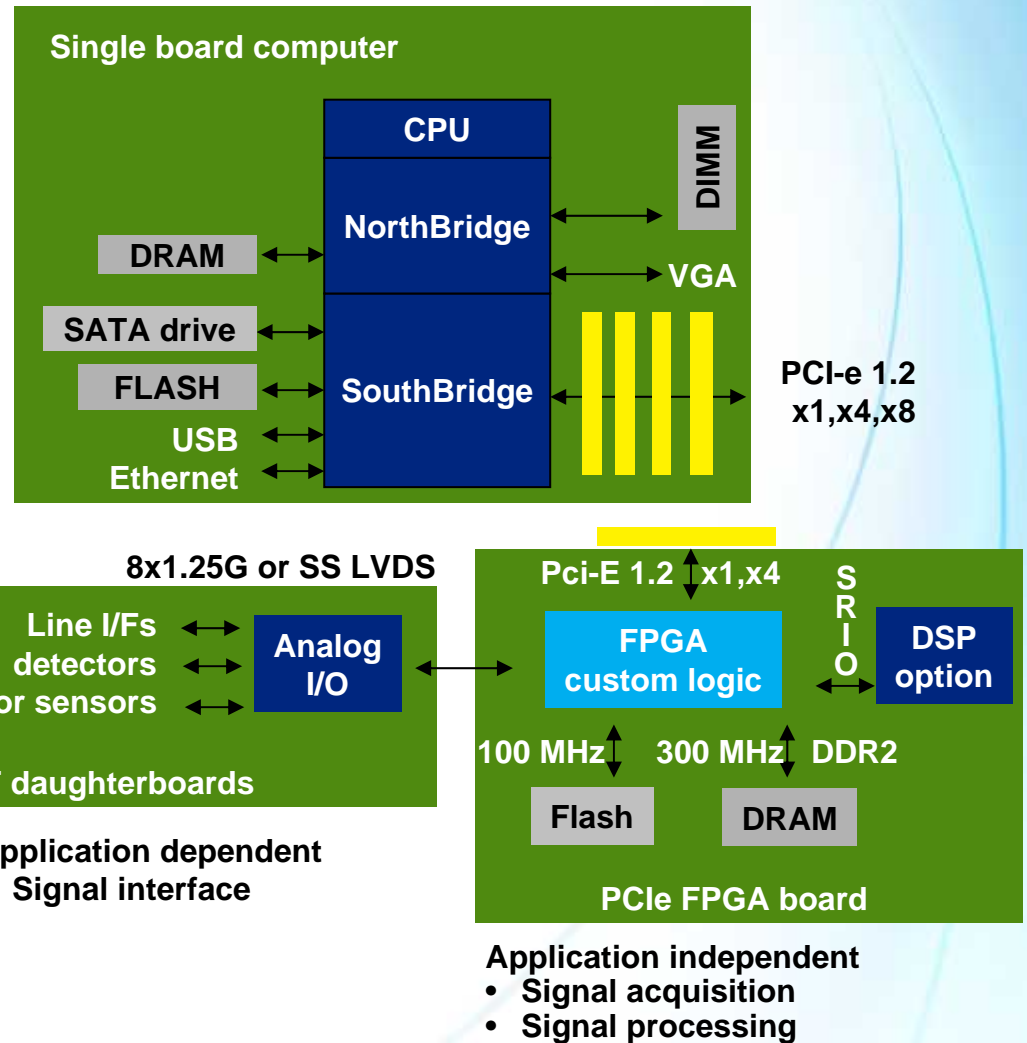
- Mobile equipment
- Patient monitoring
- Endoscopes
- Ultrasound, x-ray

- Devices:

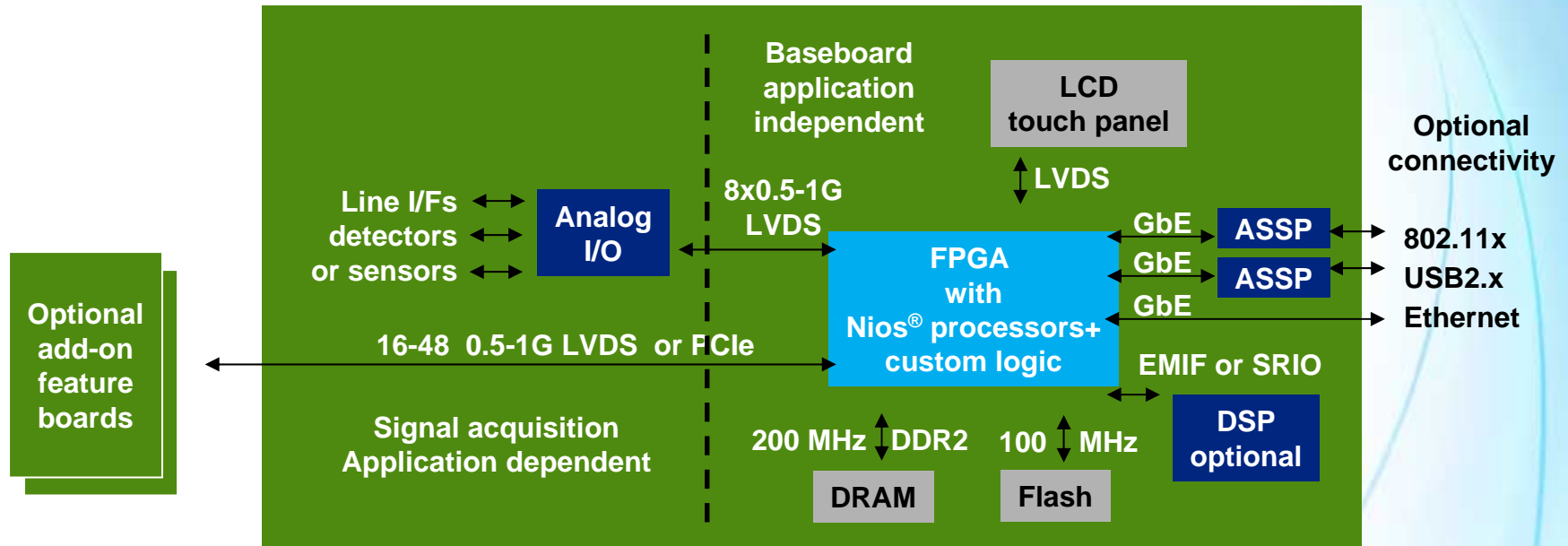
- Low end: Cyclone III FPGAs
- Stackable: Stratix III FPGAs
- Configuration and BIST:
MAX III CPLDs

- Competition:

- GPPs, DSP devices, FPGAs, ASICs



T&M Handheld Devices in 2008



■ Applications:

- Low-end patient monitoring, portable ultrasound, endoscopes

■ Device:

- Mid-range: Cyclone III; High-end: **HardCopy[®] III**, MPU, configuration and BIST: **MAX III**

■ Competition:

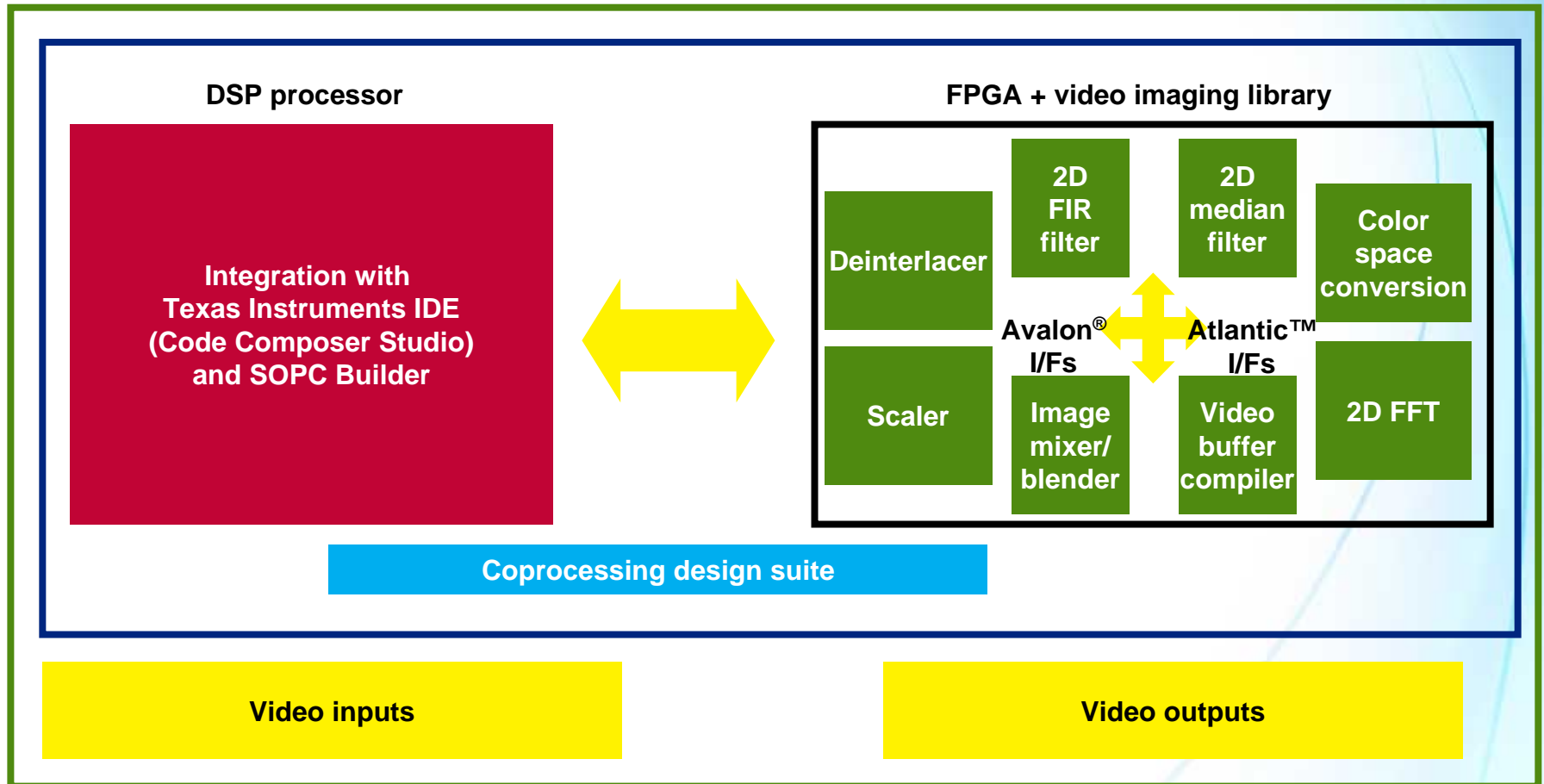
- Low-end: **MCUs**, DSP devices, ASICs

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Altera Technology Solutions



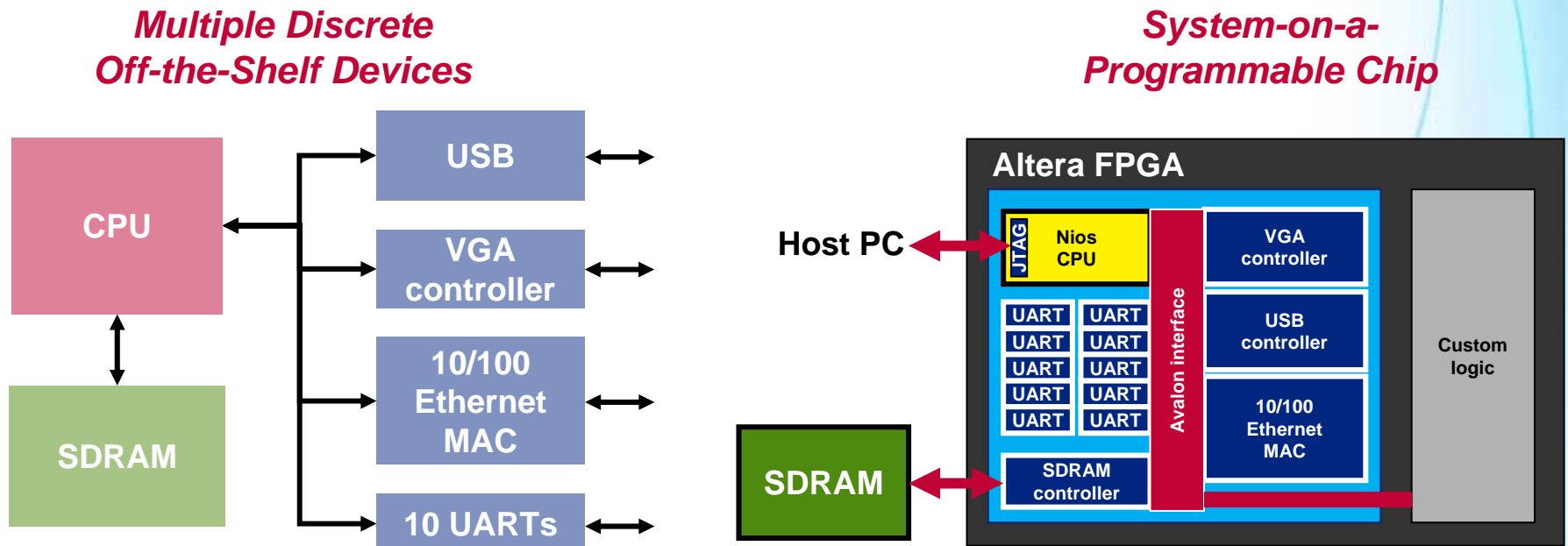
Video and Image Processing Suite



Video hardware platforms – development kits and reference designs

Deliver Faster Results and Lower Cost

- Use Nios II embedded processor and SOPC Builder for system integration

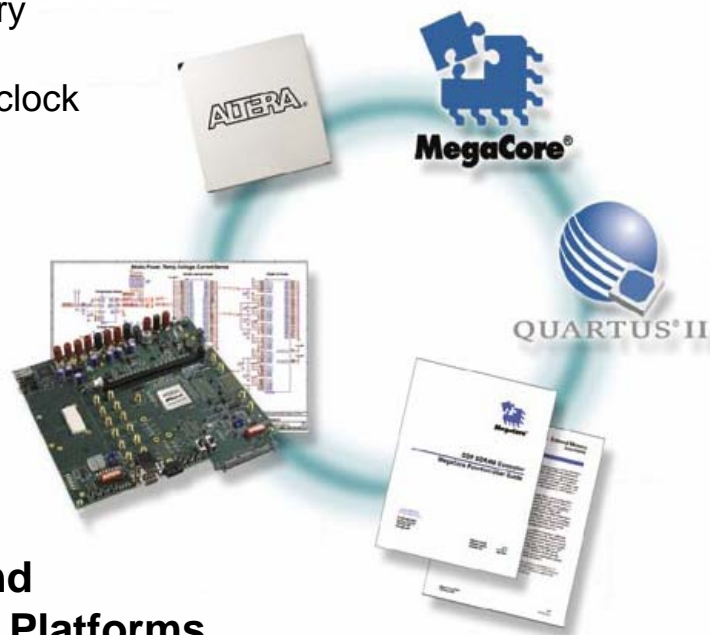


1 Quarter Saved on Two-Year Project!

Complete Memory Solutions

Advanced FPGA Architecture

- DQS phase shift circuitry
- Six registers in I/Os
- Feature-rich PLLs and clock management



Development Kits and Hardware Reference Platforms

- Demo project
- Board design guidelines
- Schematic and Gerber files

Memory Controller MegaCore[®] intellectual property (IP)

- Open source datapath
- Reference designs
- GUI
- Included in the free IP base suite

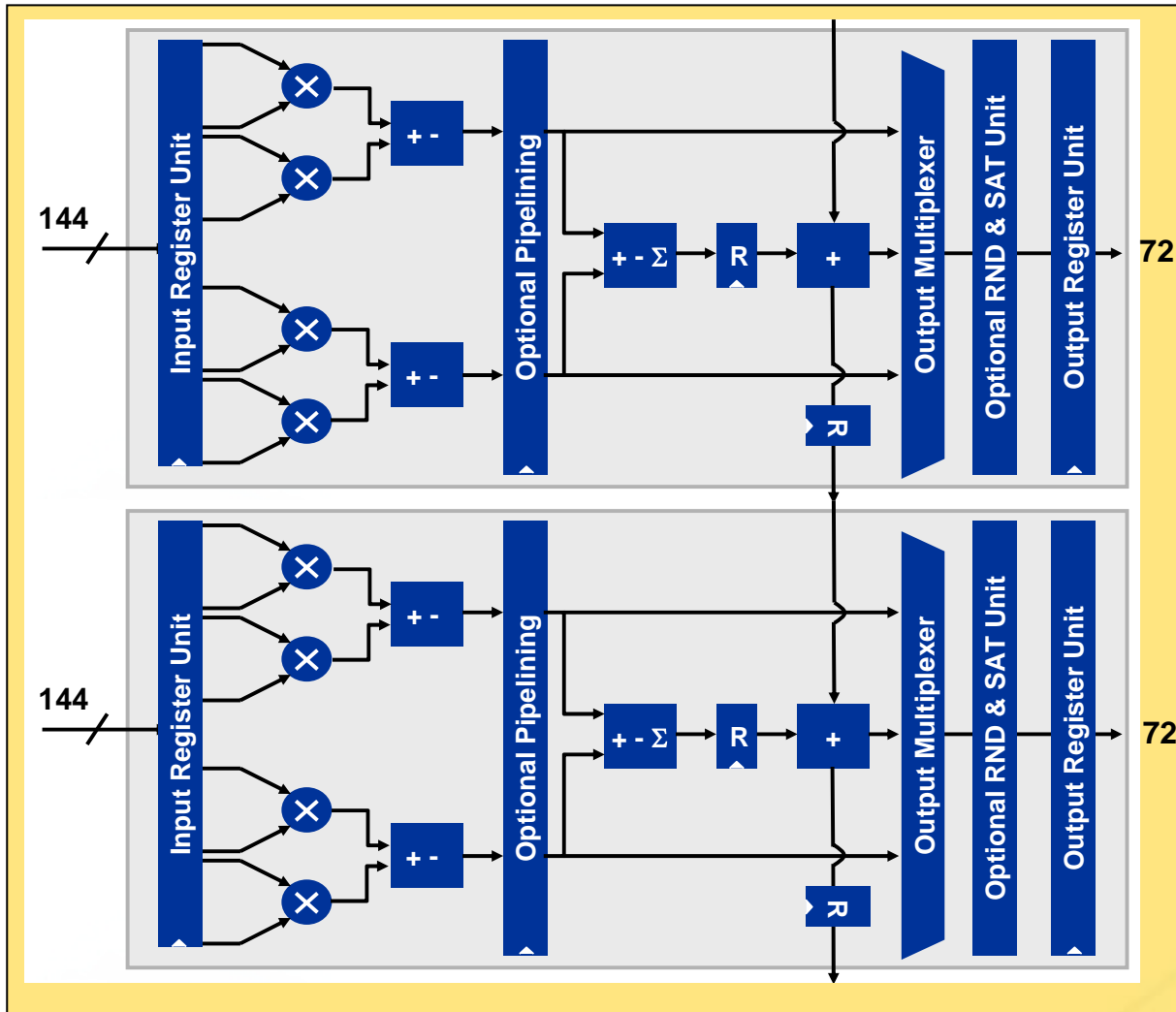
Software Support

- Automatic generated constraints
- System-level timing analysis
- SPICE and IBIS simulation models

Device Handbook, Application Note

- Interface description
- Timing analysis
- Electrical analysis

DSP Blocks for DSP Algorithms



- Basic multiplier modes
 - 8 x (9x9)
 - 6 x (12x12)
 - 4 x (18x18)
 - 2 x (36x36)
 - 2 x complex (18x18)
- Sum modes
 - 4 x sum of two (18x18)
 - 2 x sum of four (18x18)
- Accumulation
 - 2 x Acc
- Cascade modes
 - Input cascade
 - Output cascade
- Rounding
 - Unbiased and biased
- Saturation
 - Asymmetrical and symmetrical
- Barrel shifter
 - Arithmetic, logical, and rotational

External Memory Interfaces

- Stratix III FPGAs are the only FPGAs in the industry to offer DDR3 interfaces

	Device family	
		Stratix II FPGAs/ Stratix II GX FPGAs
Interconnect	Performance* **	Performance
DDRIII	400 MHz	N/A
DDRII	400 MHz	333 MHz
QDR II	350 MHz	300 MHz
QDR II+	400 MHz	N/A
RLDRAM II	400 MHz	300 MHz

** Pending Characterization

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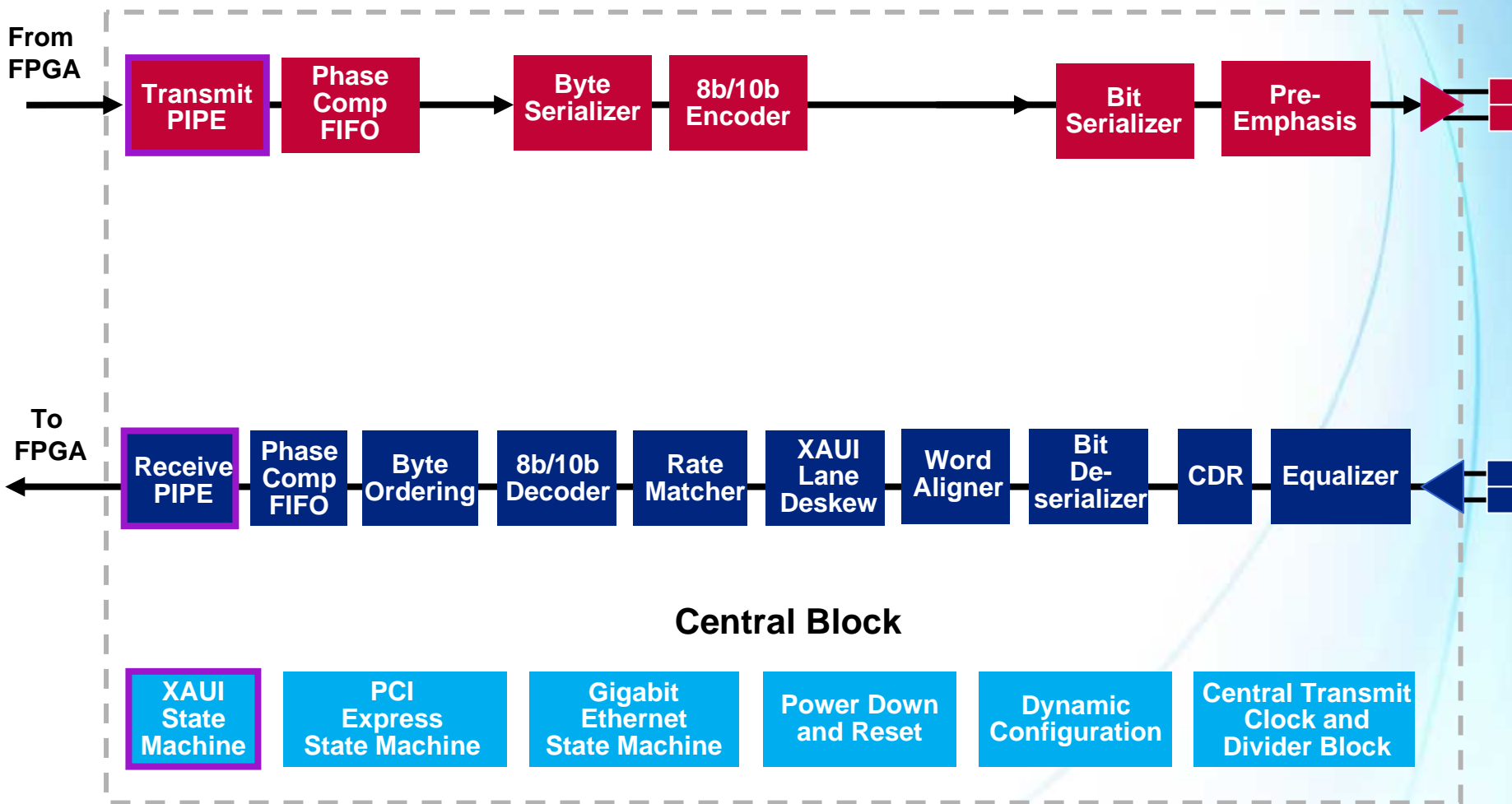
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PCI Express Solutions



PCI Express Configuration (x1, x4, x8)



PCI Express specific blocks

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Altera PCI Express Solutions

- Complete, easy-to-use PCI Express solutions
 - x1, x4 and x8 endpoints
 - Industry-leading design flow with Altera IP MegaCore function
 - Stratix II GX, Cyclone II, Stratix II, HardCopy II, and Stratix GX device family support
- Low-risk, hardware-verified solutions
 - Device characterization and PCI-SIG compliance workshops
 - 2 generations of FPGAs with embedded transceivers
 - Stratix GX FPGAs passed PCI-SIG compliance
 - Stratix II GX FPGAs passed PCI-SIG compliance
 - Development/demo boards

*Fastest Time-To-Market with a Reliable
PCI Express Endpoint Solution*

PCI-SIG Compliance and Interoperability

Motherboard vendor	Result
Intel	Passed
HP	Passed
IBM	Passed
ATI	Passed
nVidia	Passed
VIA	Passed

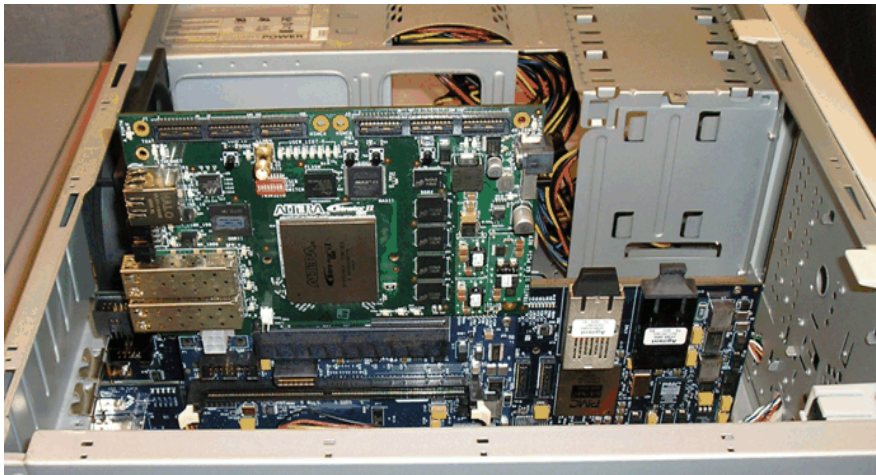
Bridge/switch tested	Result
PLX	Passed
IDT	Passed

Test equipment vendor	Result
Wavecrest	Passed
Agilent	Passed
Catalyst	Passed
Tektronix	Passed
VMETRO	Passed
Intel	Passed
LeCroy	Passed
Interoperability	Result
Freescall PowerQUICC III	Passed
IDT Switches	Passed

Passed all the PCI-SIG Gold-Suite Compliance Tests with 100% Pass Rate

Reliability - Interoperability

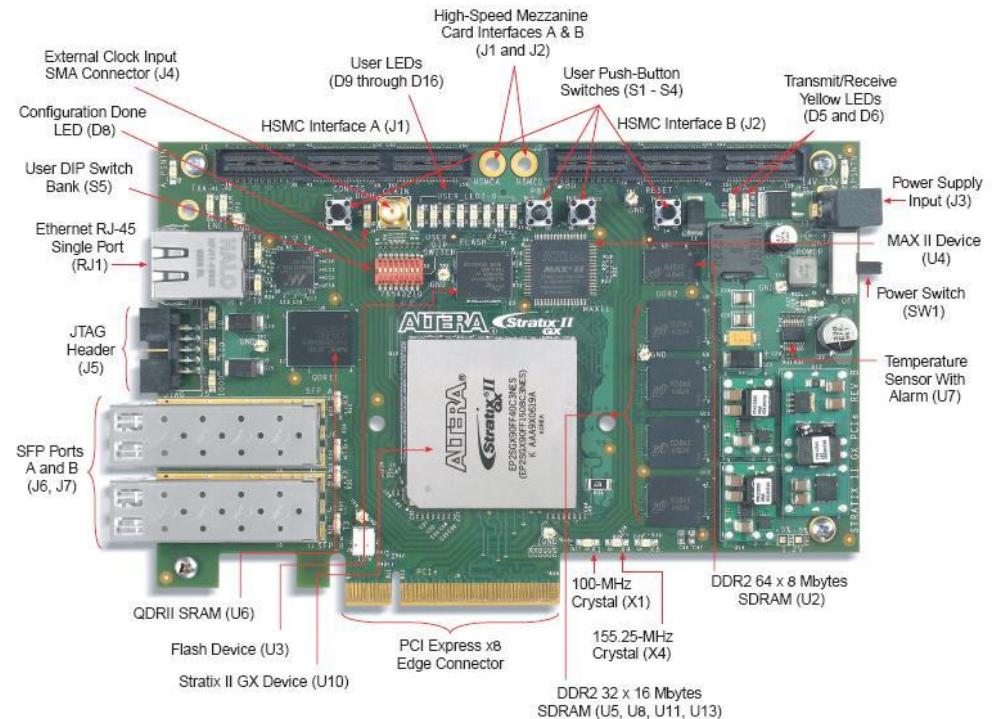
- Partnered with Freescale to create and present joint working PCI Express solution
- Demonstrated Freescale PowerQUICC III-to-Altera Stratix II GX interoperation
- Verified working PCI Express interface for up to 8 lanes



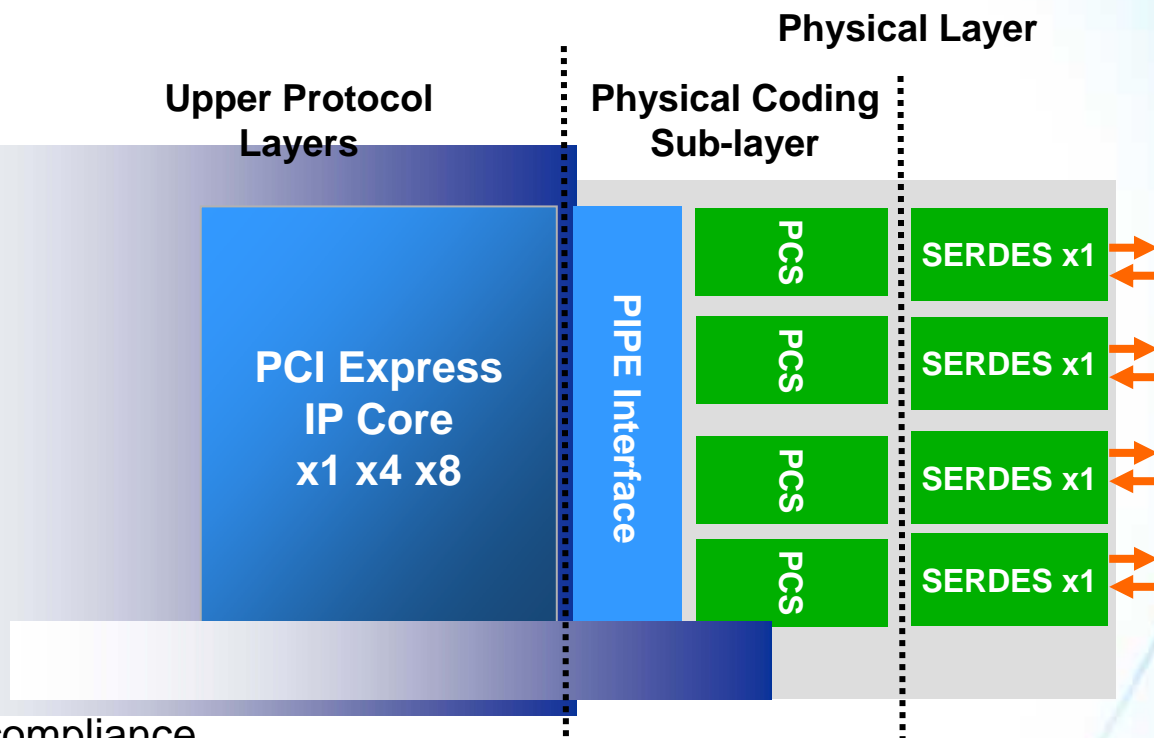
Freescale	Altera
MPC8548E	Stratix II GX FPGA
MPC8547E	
MPC8545E	
MPC8543E	
MPC8641	
MPC8641D	
MPC8572E and future MPC85xx processors with PCI Express	

PCIe Board

- EP2SGX90FF1508
- x8 PCI Express
- DDRII
 - 72 bit, 333 MHz
- QDRII
 - 36 bit, 300 MHz (350-MHz QDRII+)
- 2x SFP ports
- JTAG header
- 10/100/1G Ethernet
- 2x mezzanine connector
 - Up to 84 LVDS
 - Up to 6 transceivers
 - Up to 3 clocks
- SMA clock input
- PCI Express Development Kit
Stratix II GX Edition
DK-PCIE-2SGX90N (US \$2,995)



PCI Express IP Core



- PCI Express 1.1 compliance
- Support for up to 4 virtual channels (VCs)
- Configurable maximum payload up to 2 Kbytes
 - 128, 256, 512, 1024, or 2048 bytes
- Configurable retry buffer
- Optional end-to-end cyclic redundancy code (ECRC) generation/checking
- Optional advanced error reporting (AER)
- Flexible reference clock support (100, 125, or 156.25 MHz)

Summary

- PCI Express adopted in current and next generation medical systems
- Altera FPGAs provide comprehensive support for PCI Express
 - Arria™ GX FPGAs for mainstream applications
 - Stratix II GX FPGAs for emerging high-performance applications
- Altera PCI Express solution proven in real systems
 - Complete PCI-SIG compliance
 - Characterization reports, development kits

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PCI Express Demo

