A&D Technology, Inc.

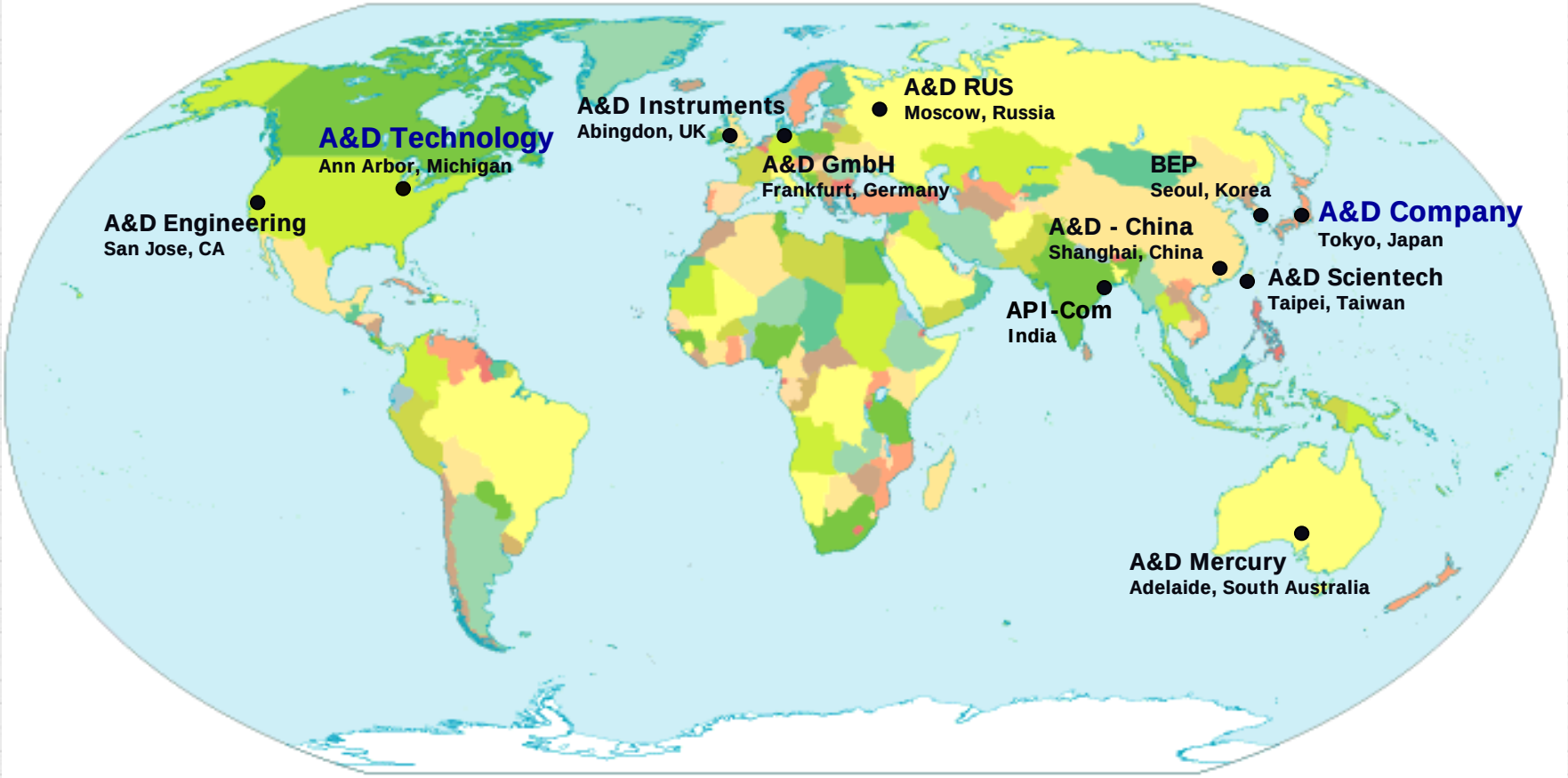
Procyon Platform

The ultra-high-performance simulation and control platform

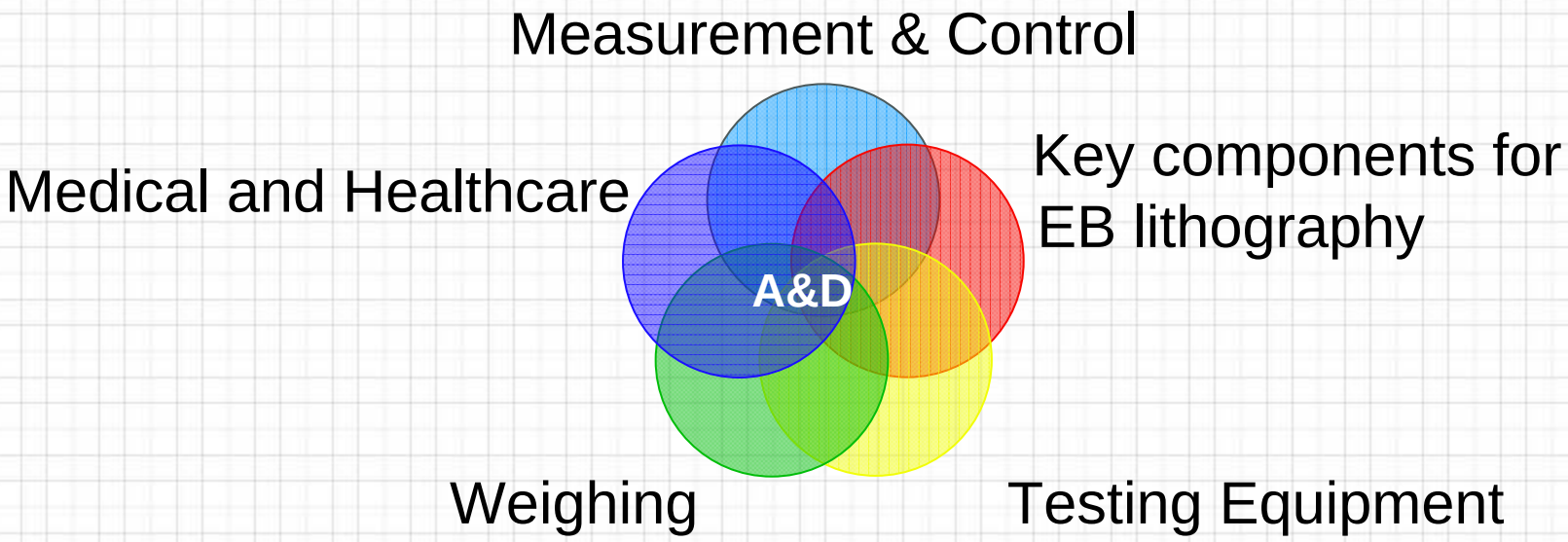
Introduction to A&D

- Headquarters in Tokyo, Japan
- Founded May, 1977
- Sales (FY07): US$350 million
- Listed at TSE I: April, 2005
- Number of employees:
  - 2751 World Wide
  - 600 in Japan
  - 92 in Ann Arbor, MI

Global Presence



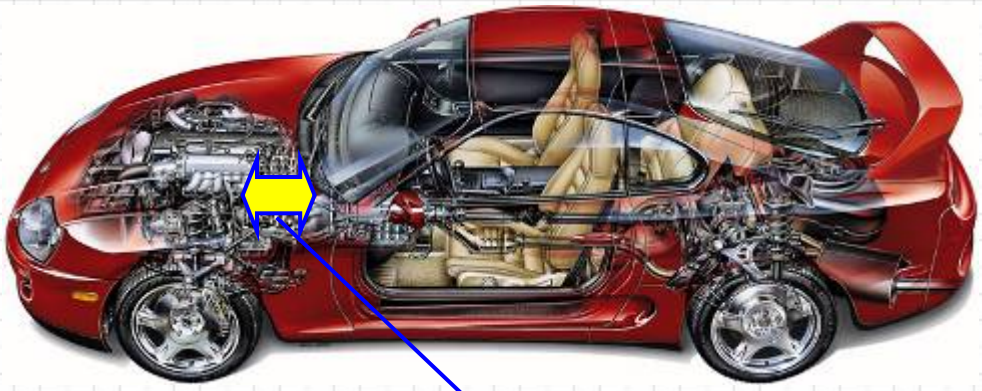
A&D Group


Measurement & Control
Medical and Healthcare
Key components for EB lithography
A&D
Weighing
Testing Equipment

A&D Product Lines

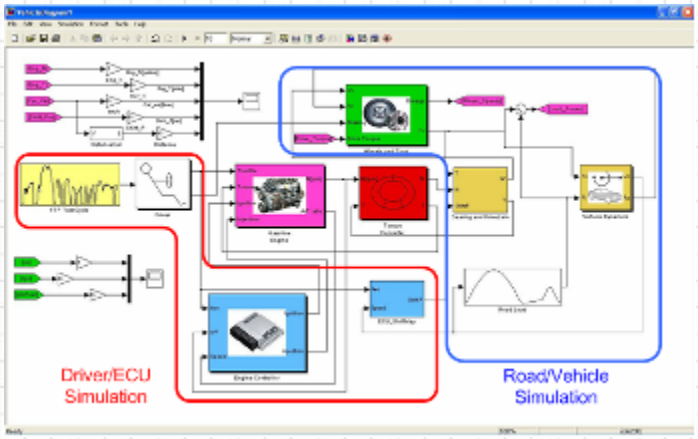
- Weighing products
  - Analytical/Precision balances
- Medical products
  - Consumer/professional blood pressure monitors
- Testing equipment
  - Vibration and noise analysis software
  - FFT spectrum analysis
  - Universal tensile testing machines
- Electron beam-related systems
- Engine Test Cell Tools
  - Combustion Analysis
  - Automated Calibration Tools
  - Lab Management
- **DSP Systems**
  - **Real-time simulation systems**
  - **Measurement and control systems**
  - **Model-based development tools**
  - **Application: Automotive, Aircraft, Power Generation plant, Defense, etc.**

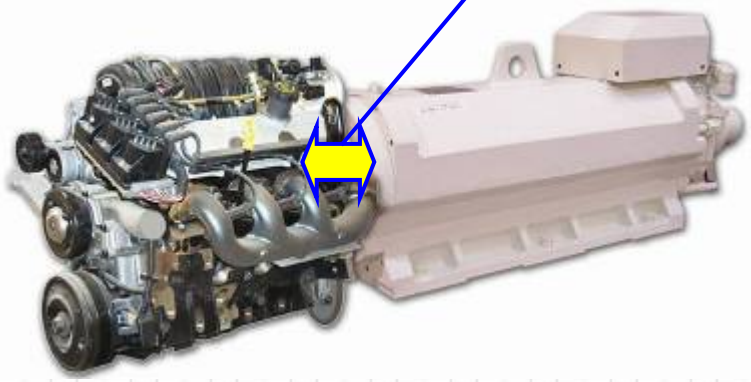
DSP Application
Vehicle Simulation in the Test Cell



Real World

Speed/torque between engine and vehicle = Speed/torque between engine and dyno





Engine in the Loop Vehicle Simulation

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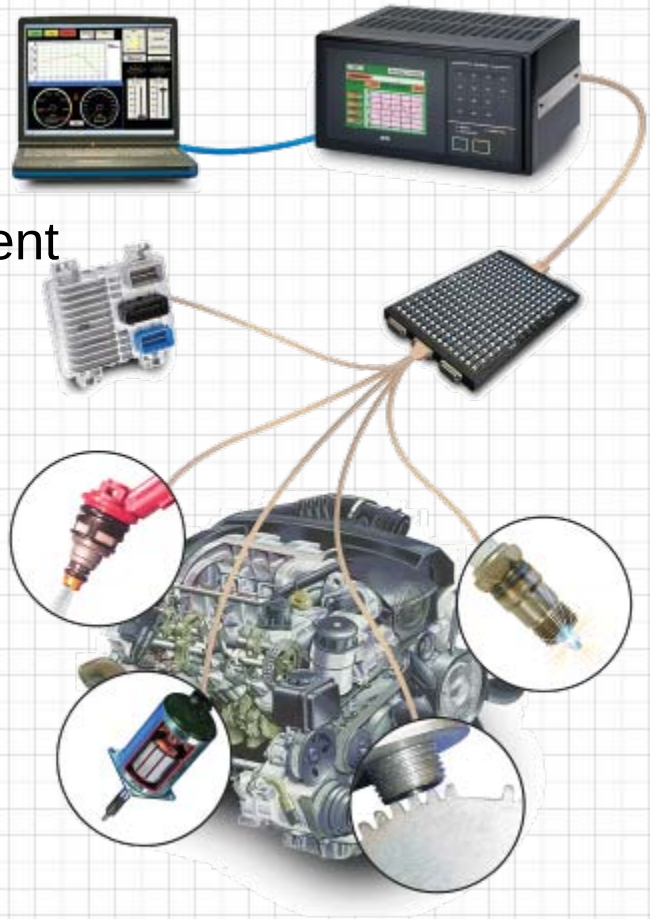
DSP Application
Engine Control

- Test cell specific
  - Tasks: competitive benchmarking, aftertreatment and catalyst testing/aging, engine mapping, transient studies, component testing/development, base calibration work, knock/misfire studies, etc.
- Customer motivation
  - Complete control over ECU
    - Flexible vs. fixed
    - Targeted applications
  - Expandable for future tests, control, I/O…



Customer's requests

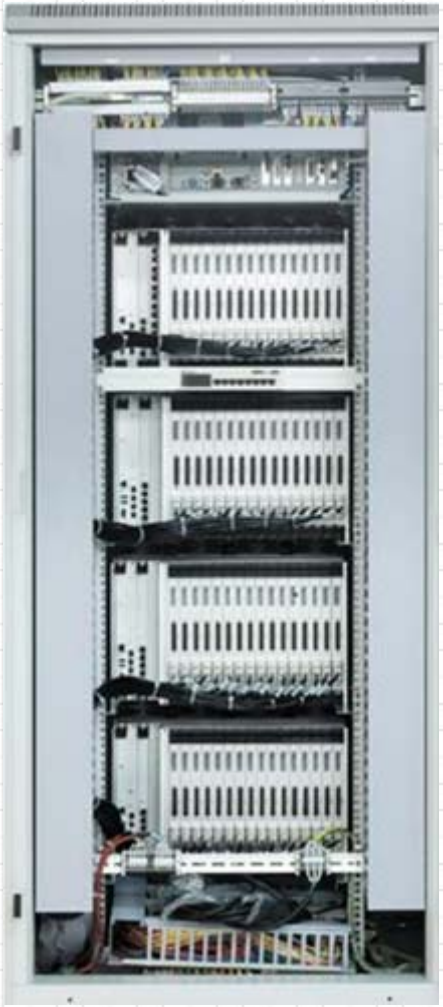
- Current platform Limitation
  - Single CPU for model execution
  - PCI base shared bus architecture

- Customer's requests for next generation platform
  - Larger models
    - Complicated model
      - Hybrid Vehicle, Aircraft, etc
    - Large number of I/O
  - Faster model cycles
    - Electrical simulation/control (ex. Motor simulation/control)
      - >100kHz Input-output loop

Procyon Platform

What is Procyon?

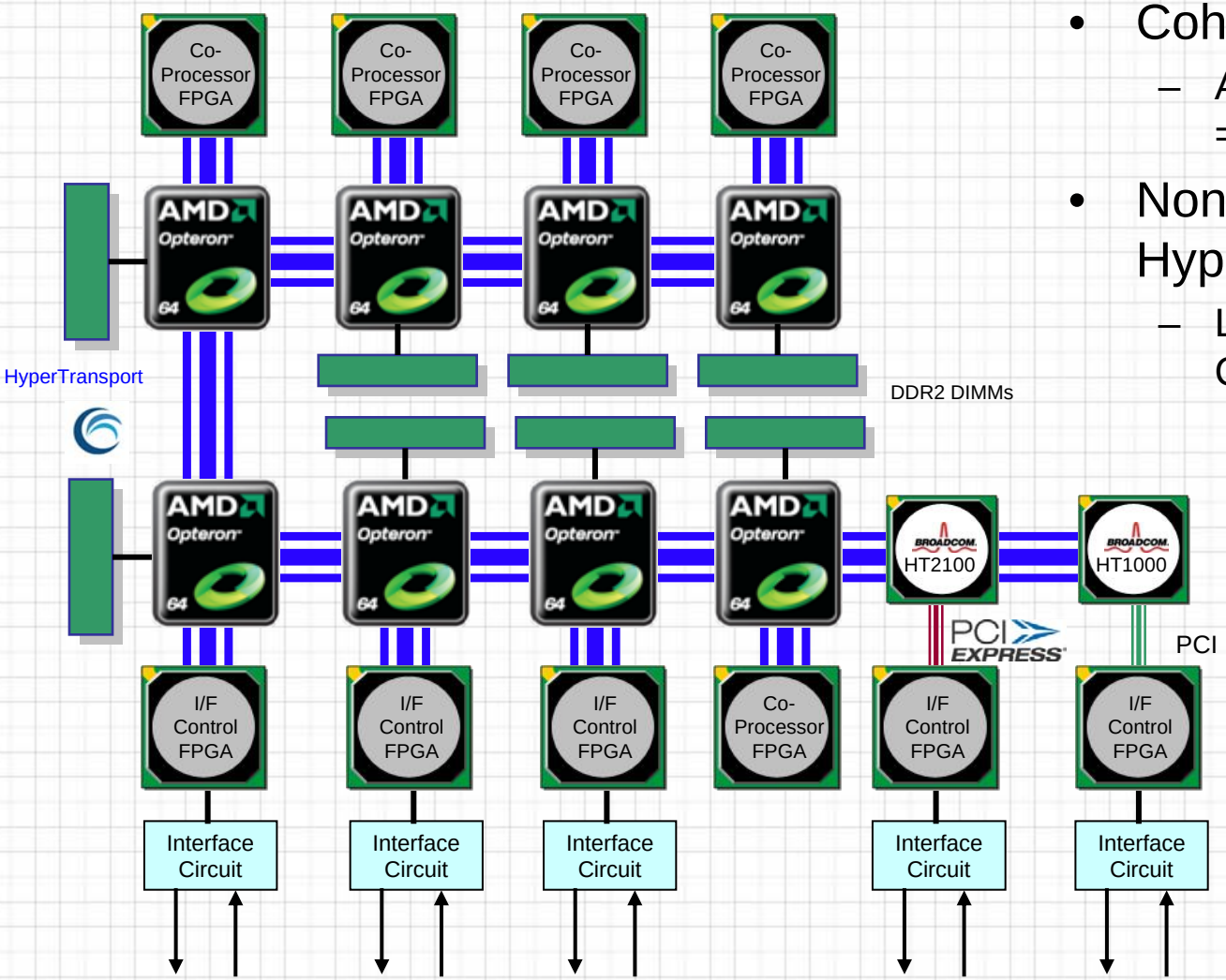
- Next generation DSP Platform
- Supports Multi-Core/Multi-CPU (max 32 CPU cores in one box)
- High Performance I/O Boards with HyperTransport and PCI Express
- User-programmable FPGA Co-Processors
- Support CompactPCI Standard Peripheral Boards
- Efficient Multi-Core/Multi-CPU Programming and Execution Environment with The Mathworks MATLAB/Simulink
- Open System



Why HyperTransport?

- Open Specification
  - Open HT core was available(University of Heidelberg)
- High performance
  - Low Latency I/O
    - Direct I/O connect architecture to AMD Opteron
  - High speed and wide bandwidth interface
    - Bi-directional high speed interface
      - » HT200, 16bit 1.6GByte/s for I/O interface
      - » HT1000, 16bit 8GByte/s for CPU-CPU connection
- Flexible Configuration
  - Add Opteron CPU or I/O interface

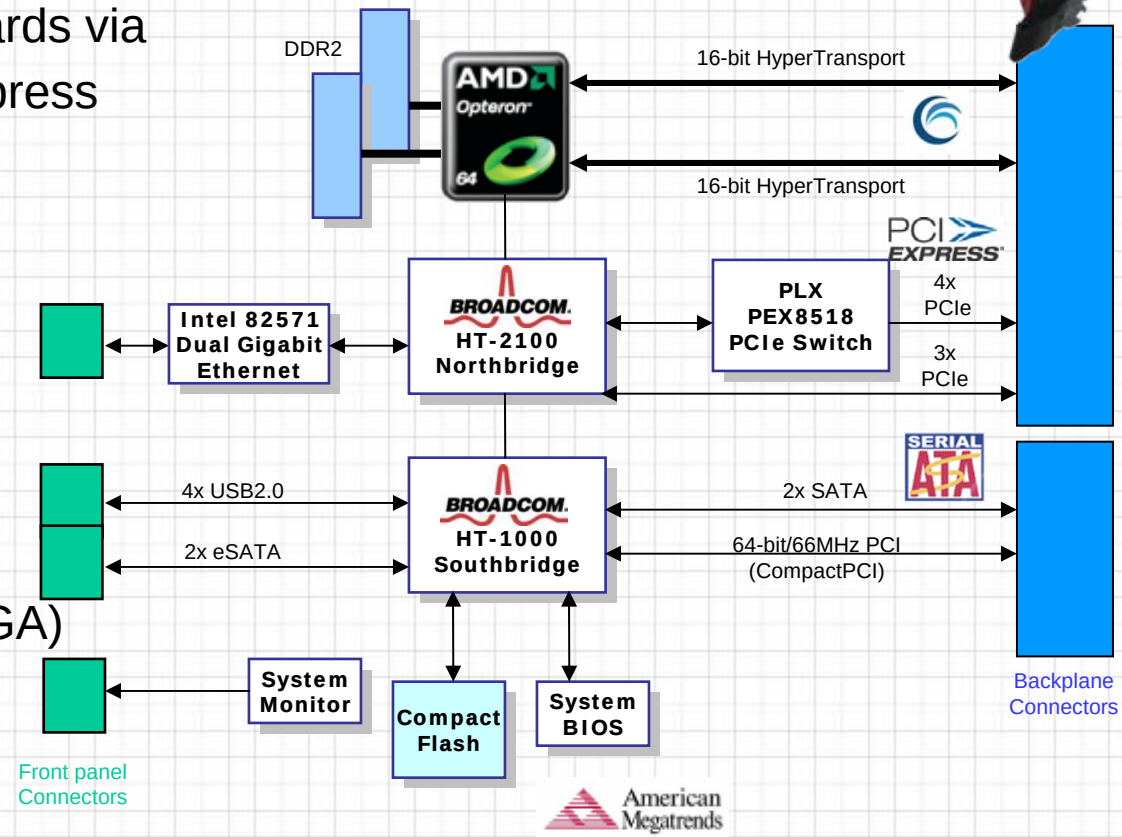
Procyon System Internal Architecture



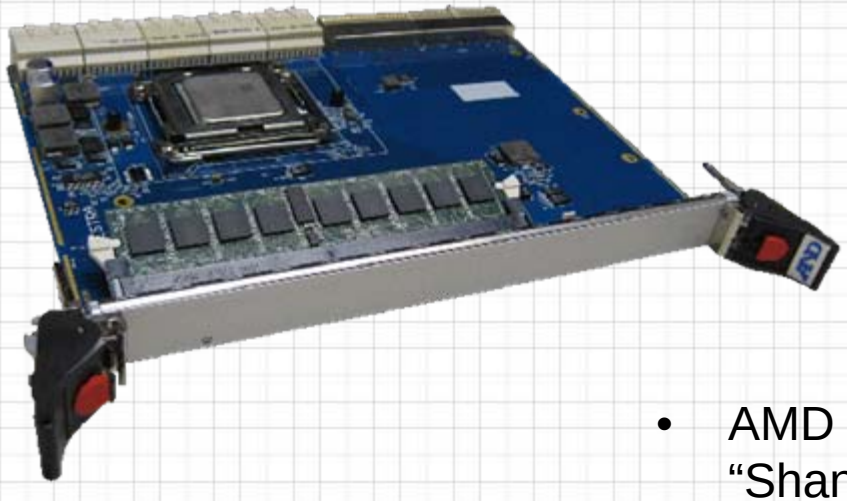
- Coherent HyperTransport
  - AMD Opteron Quad Core x 8 = 32 Core System
- Non-Coherent HyperTransport
  - Low Latency Direct I/O Connection to CPU

Castor
AD7003 Procyon System SBC

- AMD Opteron™ (supports Quad-Core “Shanghai” processor family)
- Broadcom HT2100/HT1000 Chipset
- Connects to peripheral boards via HyperTransport or PCI Express
- DDR2 DIMM x 2
- Gigabit Ethernet x 2
- USB2.0 x 4
- VGA
- SATA and eSATA
- System monitor function
- AMI BIOS (supports ncHT & cHT FPGA)
- Supports CompactPCI peripheral boards

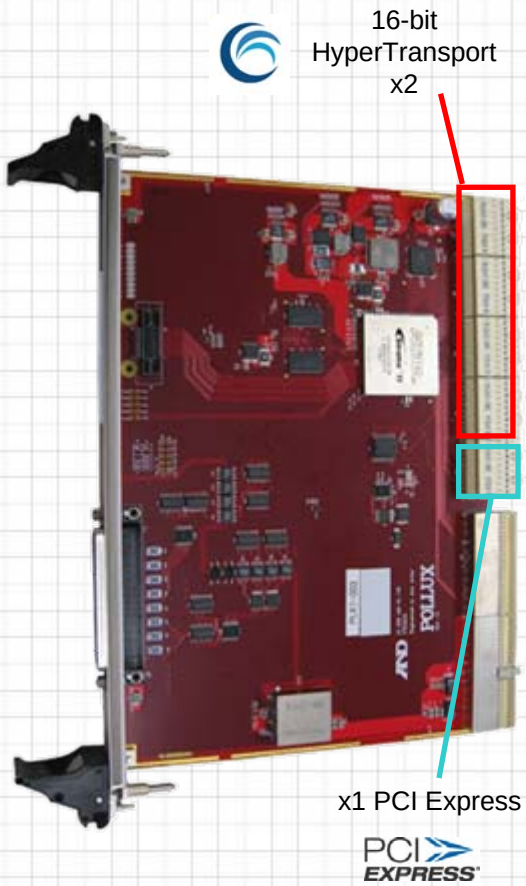


Nestra
AD7003-01 : Calculation Engine Board



- AMD Opteron™ (supports Quad-Core “Shanghai” processor family)
- DDR2 DIMM
- HyperTransport Interfaces
  - –2x 16-bit bi-directional
  - –1x 8-bit bi-directional

Pollux: Interface Evaluation Board

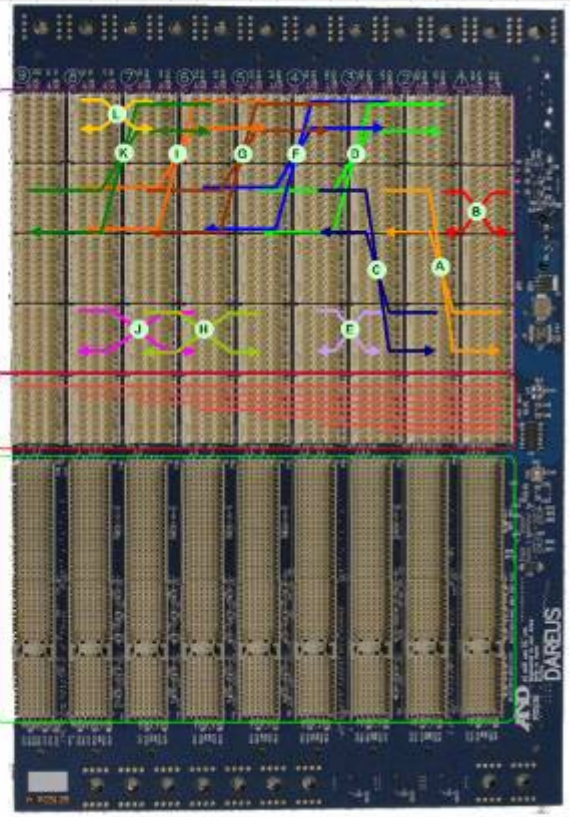


- Interfaces:
  - HyperTransport
    - 2x 16-bit bi-directional HyperTransport links
    - HT Core with HT200 and 16bit wide links with University of Heidelberg HyperTransport core
  - PCI Express
    - x1 [single lane] configuration
- I/O
  - Magnetically Isolated I/O
    - 8 in, 8 out
  - Logic Analyzer Connection
    - 32 data, 2 clocks
- FPGA
  - Altera Stratix II
    - Standard build: 60k LUT, speed grade 3 (fastest)
    - Custom build: up to 180k LUT

Dareus
Procyon System Backplane

Supports 3 types of Interconnections:

- HyperTransport
  - High speed point-to-point communication
  - 16 Bits x 1000 MHz x 2 transfers/clk x 2 (each direction) = 64 Gbit/s
  - Multi-CPU environment; max 8 CPUs supported
  - Direct connect I/O interface to CPU → Low latency I/O
- PCI Express
  - x1 [single lane] configuration
- Conventional PCI
  - 64bit/33MHz
  - Supports off-the-shelf CompactPCI peripheral boards
  - A&D specific extension for backward compatibility for A&D boards



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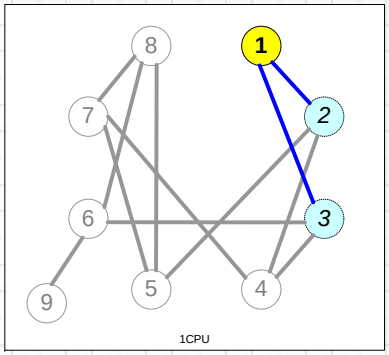
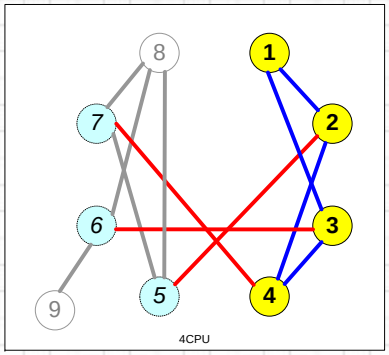
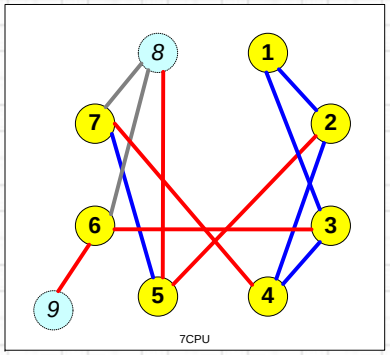
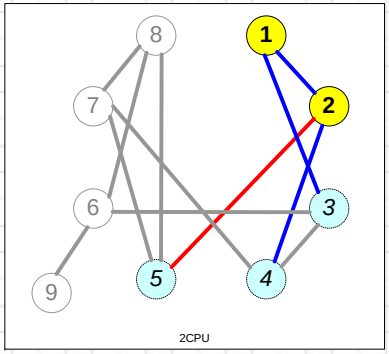
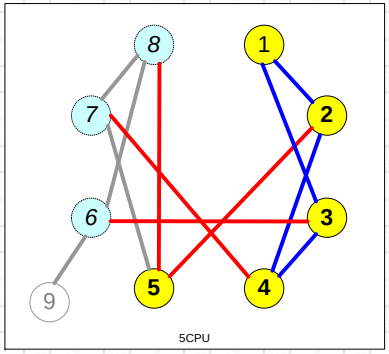
40HP Procyon System Backplane Configuration Options

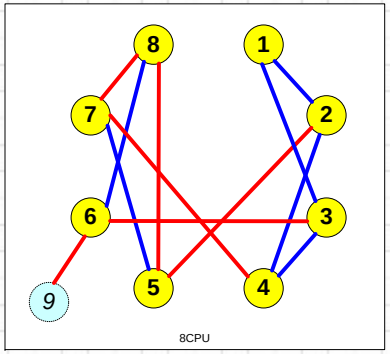


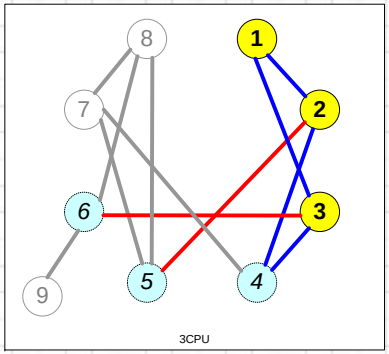


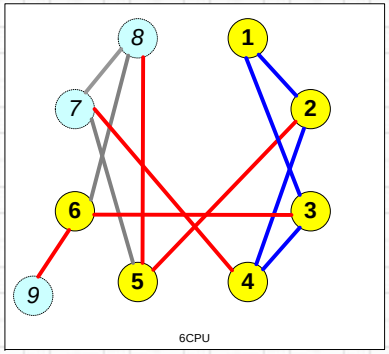












X CPU

Y I/O or FPGA Co-Proc Board

16bits, 1GHz

8bits, 800MHz

Unused Link

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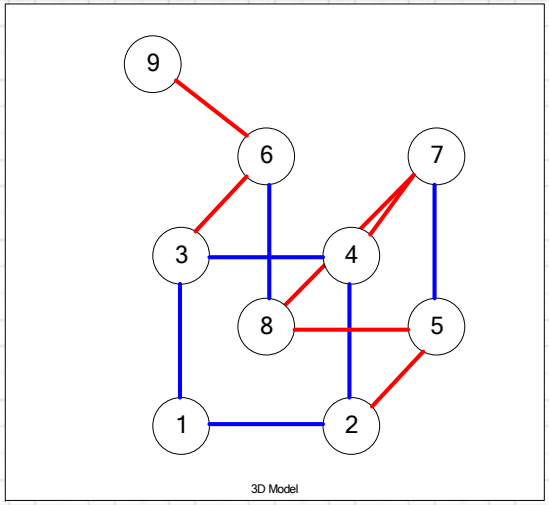
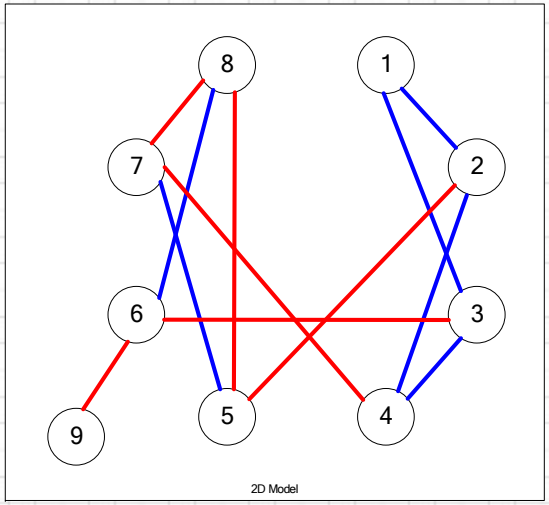
40HP Procyon System Backplane Internal Connection



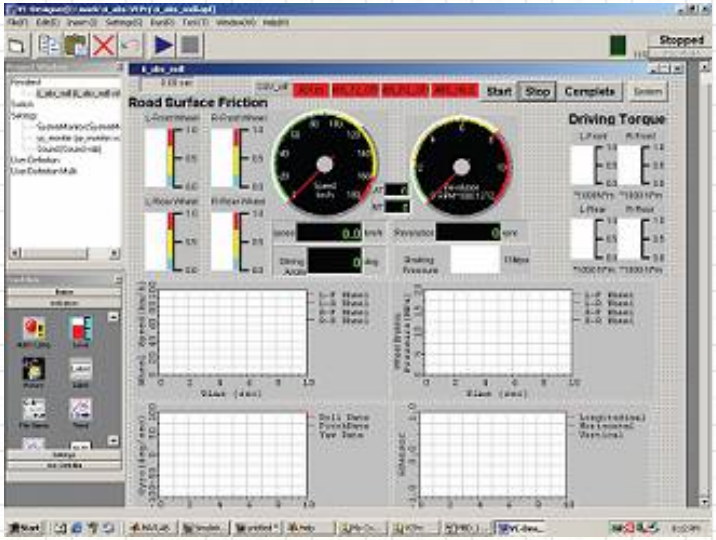


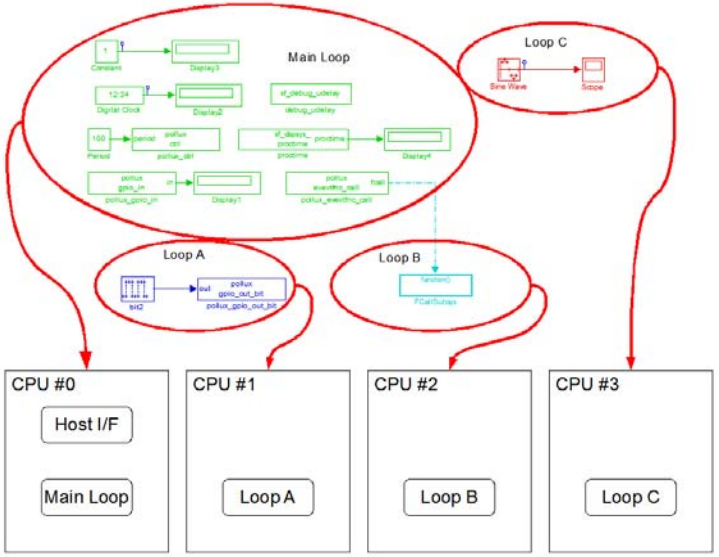
Node	Node	#Hop	Num of 8bit/800MHz Link	Node	Node	#Hop	Num of 8bit/800MHz Link
1	2	1	0	4	5	2	1
	3	1	0		6	2	1
	4	2	0		7	1	1
	5	2	1		8	2	1
	6	2	1		9	3	2
	7	3	1	5	6	2	1
	8	3	1		7	1	1
	9	3	2		8	1	1
2	3	2	0		9	3	2
	4	1	0	6	7	2	2
	5	1	1		8	1	1
	6	3	1		9	1	1
	7	2	1	7	8	1	1
	8	2	2		9	3	2
	9	4	2	8	9	2	1
3	4	1	0				
	5	3	1				
	6	1	1				
	7	2	1				
	8	2	1				
	9	2	2				

16bits, 1GHz
8bits, 800MHz

Software Environment

- Model-based real-time development environment with MATLAB/Simulink
- Efficient multi-core/multi-CPU programming platform on real-time OS
- Visual system front-end: VirtualConsole
  - Drag-and-drop, menu driven GUI application design and execution tool
  - Flexible and customizable architecture





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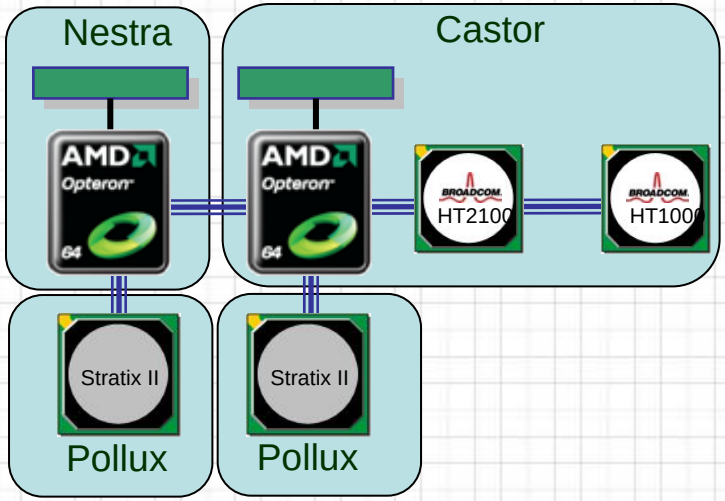
System Evaluation

- ***Hardware Environment***
  - Dareus
    - 9 slot Backplane
  - Castor (AD7003)
    - Quad-Core AMD Opteron 8378 (Shanghai)
    - 2x 1GB DDR2 800 DRAM
  - Nestra (AD7003-01)
    - Quad-Core AMD Opteron 8378 (Shanghai)
    - 1GB DDR2 800 DRAM
  - 2 x Pollux
  - Backplane Configuration
    - Castor – Nestra – Pollux – Pollux
- ***Software Environment***
  - Linux Kernel 2.6.26.7
    - 64bit/NUMA Configuration
  - Xenomai 2.4.6.1



System Evaluation

- Benchmark Result
  - Can achieve 2us (500kHz) I/O loop
    - With CPU calculation
      - 750ns for Nestra
    - With 256Byte bi-directional DMA
    - With System Stress (Memory access, HDD access, Ethernet Transaction, …)
      - Current Generation system I/O loop is 50us (20kHz)

System Stress	Step Size	Model Execution time	
		Castor	Nestra
N	2us	800ns	800ns
Y	2us	350ns	750ns
N	3us	1800ns	1800ns
Y	3us	1200ns	1750ns

Procyon Applications

Stanford Pervasive Parallelism Laboratory

- Goal: researching the parallel computing platform for 2012
- Director: Kunle Olukotun
- Involves architecture, algorithms, programming models

Research Methodology

- Conventional approaches are still useful
  - Develop app & SW system on existing platforms
    - Multi-core, accelerators, clusters, …
  - Simulate novel HW mechanisms
- Need some method that bridges HW & SW research
  - Makes new HW features available for SW research
  - Does not compromise HW speed, SW features, or scale
  - Allows for full-system prototypes
    - Needed for research, convincing for industry, exciting for students
- Approach: commodity chips + FPGAs in memory system
  - Commodity chips: fast system with rich SW environment
  - FPGAs: prototyping platform for new HW features
  - Scale through cluster arrangement

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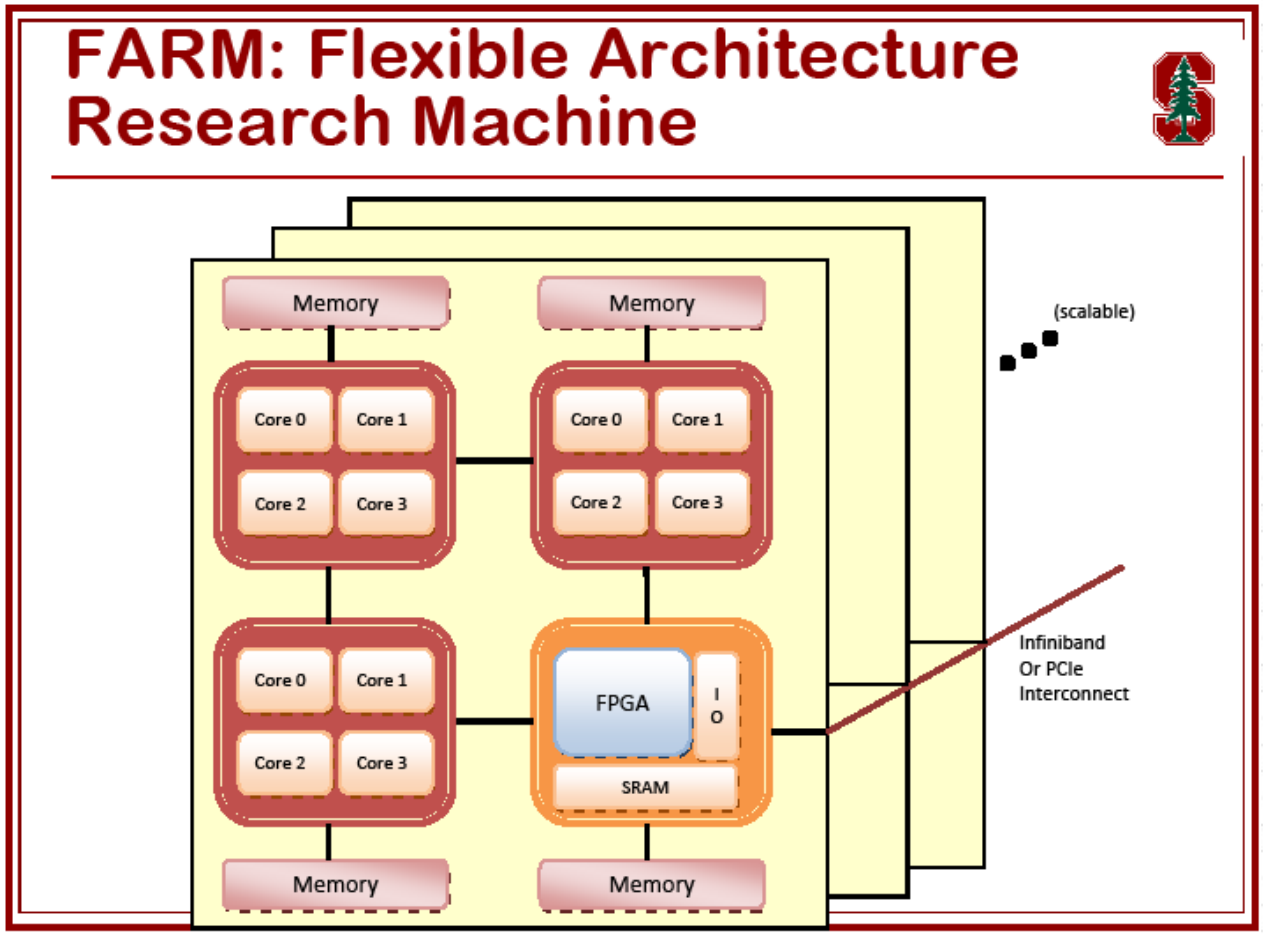
Stanford FARM: Flexible Architecture Research Machine



- Commodity CPUs and FPGAs in memory system
- Scales as needed

Procyon Applications

FARM: Many Possibilities

- FPGA provides great environment for evaluating architectural ideas at full system speed
  - Accelerators: video encoding, encryption, ISA extensions, etc.
  - Heterogeneous architectures
    - Simple cores on FPGA
  - Hardware schedulers
  - Maintain rich software support via OS, etc.
- Platform with high bandwidth, low latency, coherent link to FPGA
  - Great for FPGA-based simulators in RAMP

- **Potential Procyon Research Areas**
  - **Transactional Memory**
  - **New Processor Architectures**
  - **Compute Acceleration Algorithms**
  - **Application Specific Co-Processors**
  - **High Speed Interconnect**

System and Application Boards *(Planning)*

Single Board Computer

- AD7003 Procyon SBC with AMD Opteron Processor

Calculation Accelerator

- AD7003-01 CPU Co-Processor Board with AMD Opteron Processor
- AD5440-xx FPGA Co-Processor Board

Hyper Transport I/O Boards

- AD5440-HT01 Engine HIL Board
- AD5440-HT02 Motor HIL Board
  (support electrical JMAG motor model under consideration)
- AD5440-HT11 PWM/Digital I/O Board

PCIe I/O Boards

- AD5440-PX04 1.25MHz-Sampling/12ch Combustion Analysis Board
- AD5440-PX06 NVH Analysis Board

Application and General Purpose Boards (Planning)

cPCI I/O Boards (Compact PCI Base)

- AD5440-01 32ch Analog Input Board
- AD5440-02 32ch Analog Output Board
- AD5440-03 Digital I/O Board (Flex-channel)
- AD5440-06 Multifunction I/O Board (A/D12ch, D/A8ch, DI 16ch, DO 16ch)
- AD5440-08 Servo Controller (4ch Input/1ch Output)
- AD5440-09 8ch Strain Gauge Input Board (Simultaneous Sampling)
- AD5440-10 Box-to-Box Synchronization Board
- AD5440-11 PWM I/O Board
- AD5440-15 Box-to-Box Communication Board
- AD5440-17 Network Board (CAN, Serial, K-Line, Lin)
- AD5440-20 16ch/250kHz Analog Input Board (Simultaneous Sampling)

Collaboration Plan

- Open Specification
  - Enables 3rd-party Peripheral board development
- Development Environment Kit
  - SBC (Castor)
  - Backplane (Leda)
  - HyperTransport and PCI Express Evaluation I/O Board (Pollux)
- Software Environment
  - Standard x86 platform
  - Real-time OS Available
  - Supports The MathWorks MATLAB/Simulink
  - Application Design Environment (VirtualConsole)
  - Support 3rd-party Software Execution (Vehicle model, Engine model, etc.)

Thank you for your attention

A&D Technology, Inc.

Contact: procyon@aanddtech.com