



The Future  
of  
INDUSTRIAL COMPUTING

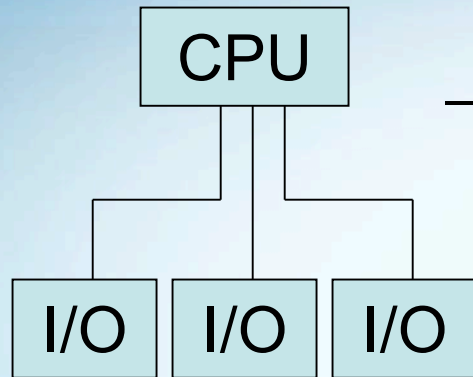
# ExpressNet™ and Superswitch Technology Overview

July 2007

ONE STOP  
SYSTEMS

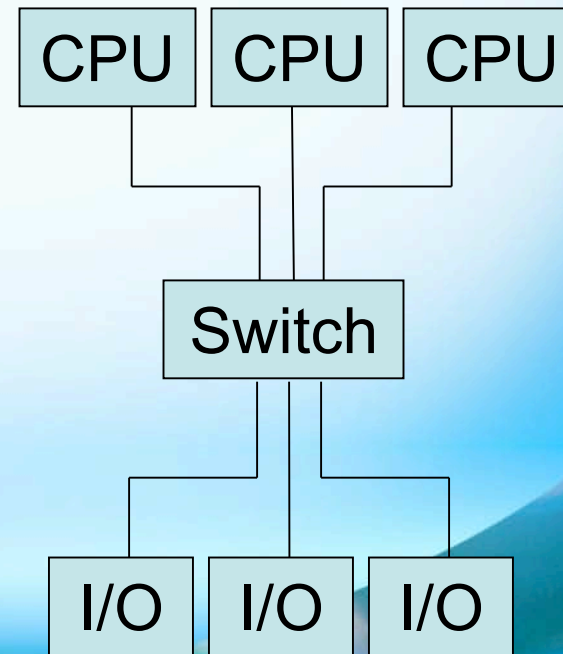
# PCI Express Basics

## Two Architectures



- Tree – One CPU and multiple I/O boards
  - Available now

- Network – Multi CPUs, Multi I/O
  - Requires Superswitch H/W and ExpressNet<sup>SM</sup> S/W
  - Available late-2007



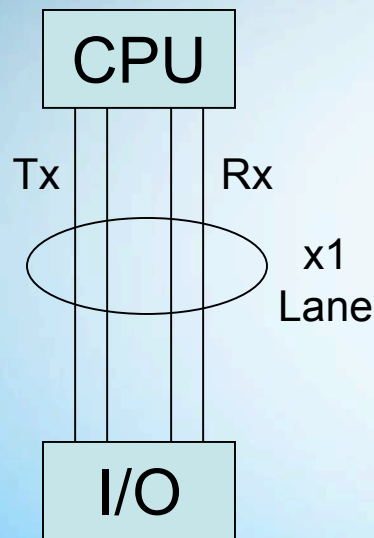
# PCI Express Basics

## Terminology

- Host = Upstream = Root Complex
  - Refers to CPU board in single-root system
- Target = Downstream = PCIe Endpoint
  - Refers to I/O board or intelligent I/O board

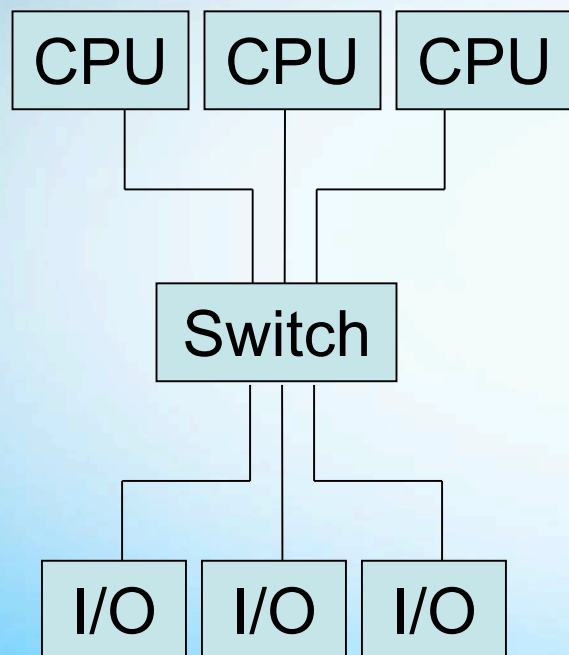
# PCI Express Basics

## Lanes – The Key to Performance



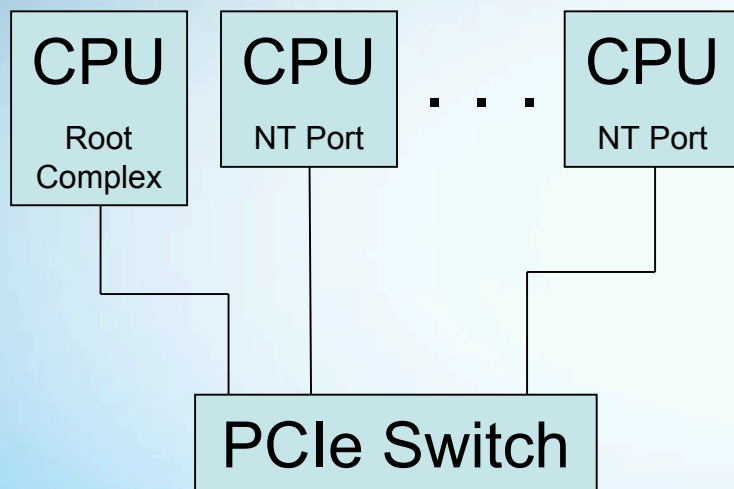
- Each lane consists of two 2.5Gbit/sec differential pairs
  - Separate Transmit and Receive pairs
  - Approximately 500MB/sec bandwidth total
- Multiple lanes are used to increase performance
  - x1 → 500MB/sec    x1 (pronounced “by one”)
  - x4 → 2GB/sec
  - x8 → 4GB/sec
  - x16 → 8GB/sec
- Gen 2 clock rate will be 5Gbit/sec
  - Doubles bandwidth
  - Components will auto-detect if they can run at 5Gbits/sec
  - Products available in 2007 or 2008 timeframe

# ExpressNet™ Overview



- A way of using PCIe to communicate between multiple CPUs
  - PCIe as a networking architecture
    - High performance
    - Low cost
    - Based on industry standards
- Works for both cabled systems and backplane systems
- Both hardware and software components

# ExpressNet™ Technology

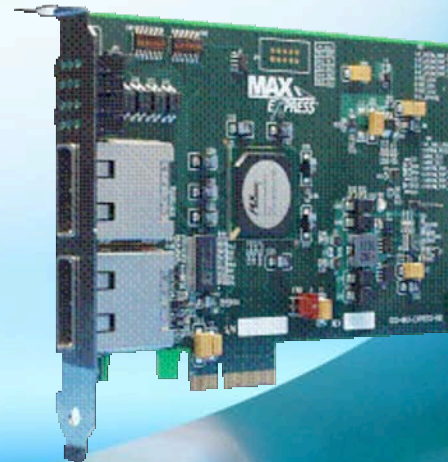
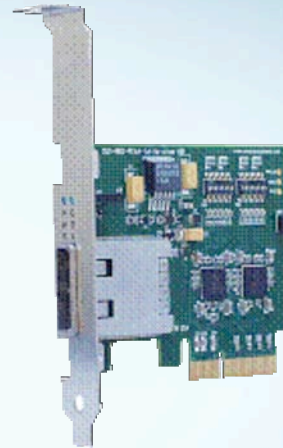


- One CPU initializes the switch components and handles the fabric management
  - The root complex CPU
- Non-transparent (NT) PCIe ports are used to make the other CPU elements PCIe end points
  - Each PCIe CPU looks like an intelligent I/O board to the system
- ExpressNet™ driver sets up memory windows from each CPU to all the other CPUs in the network
  - Driver allows direct DMA transfers
  - Driver implements TCP/IP interface
    - Looks like a NIC card to applications

# Hardware Implementations

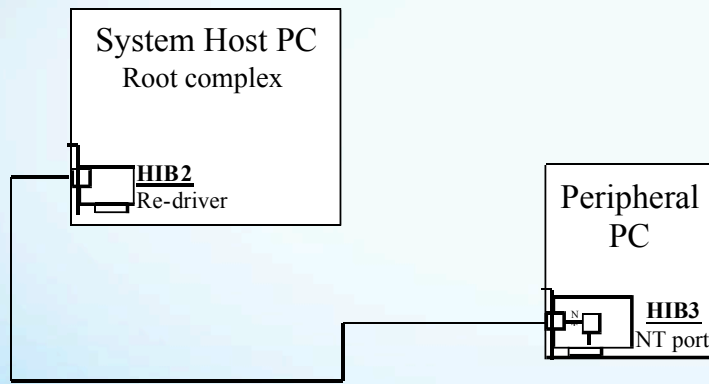
- Cabled systems with SuperSwitch™
  - Two system solution
  - 3 to 5-port solution
  - > 5-port solution
- Backplane systems with SuperSwitch™

# PCIe over a Cable – Interface Products



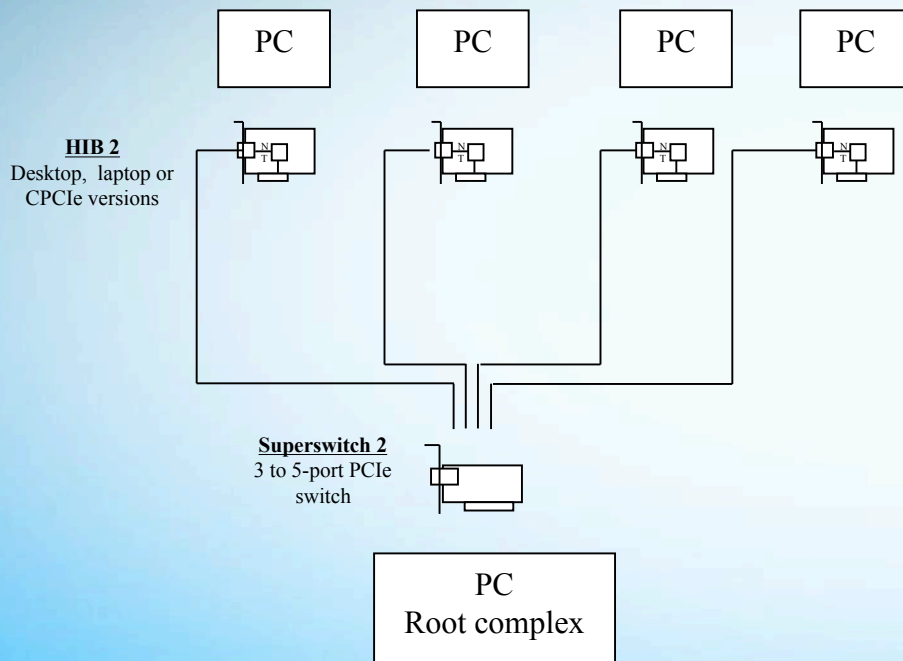
ONE STOP  
SYSTEMS

# Two System Solution



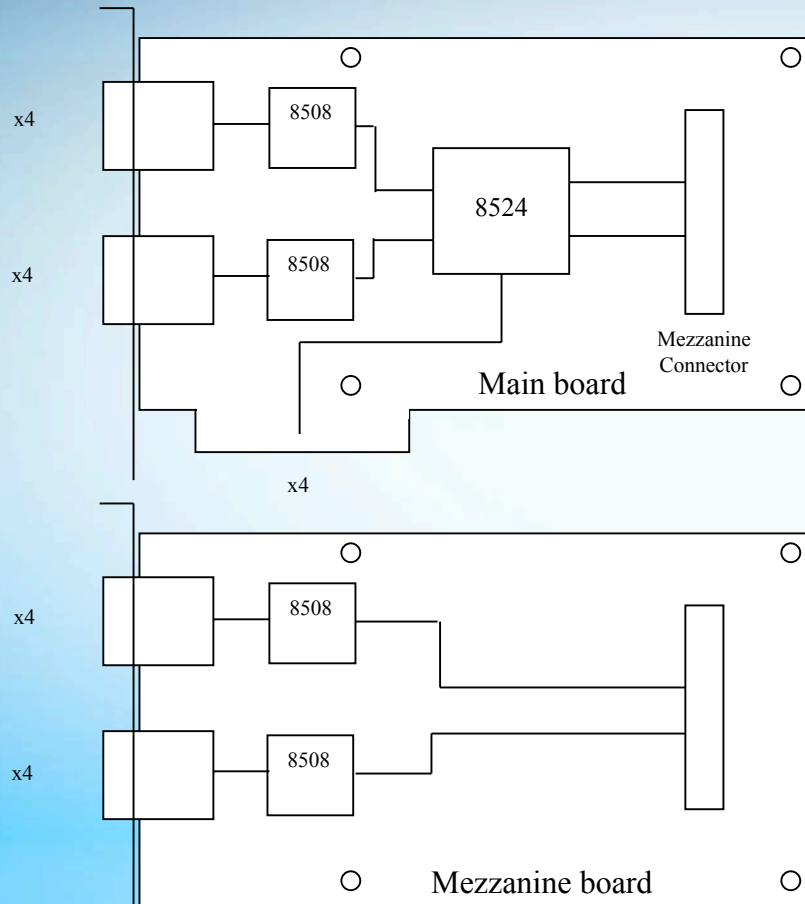
- Uses HIB-2 in one PC and HIB-3 in the other
- Demonstrated performance of 725MB/sec
- Supported in Phase I of ExpressNet

# 3 to 5-Port Solution



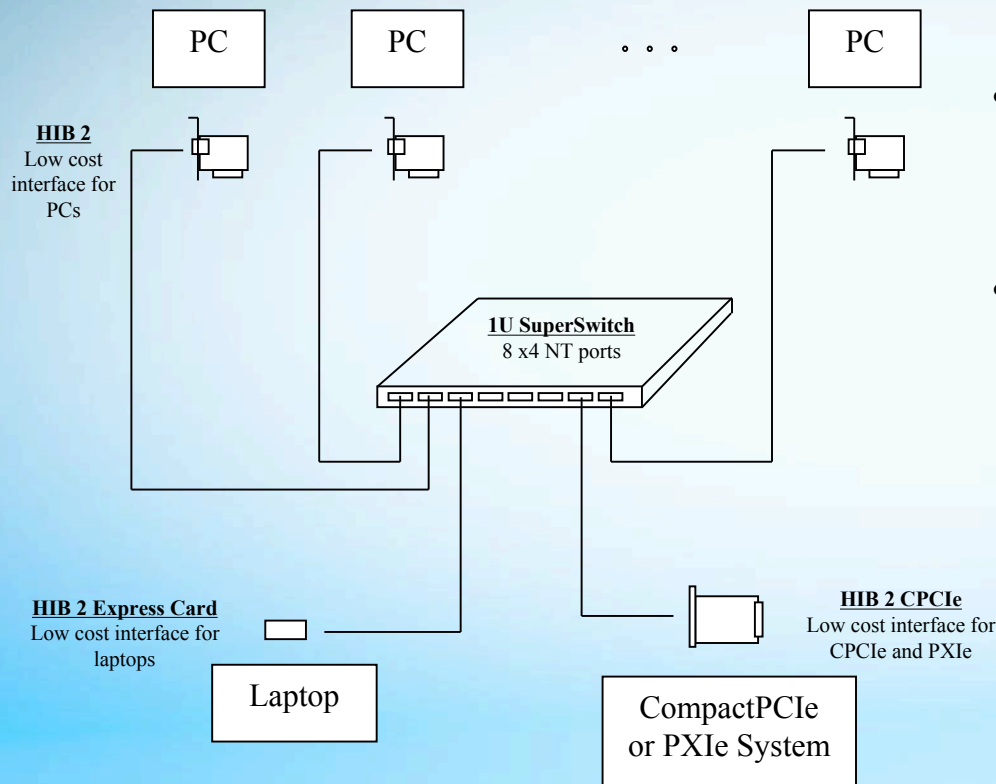
- Low-cost superswitch
  - 3 or 5-port PCIe add-in board
  - 5-port version is two slots wide
  - Connects to 4 external PCs through PCIe x4 cable
- Standard HIB-2 boards used in node PCs
  - Desktop
  - Laptop
  - CPCle

# Low-cost 3 to 5-port Superswitch



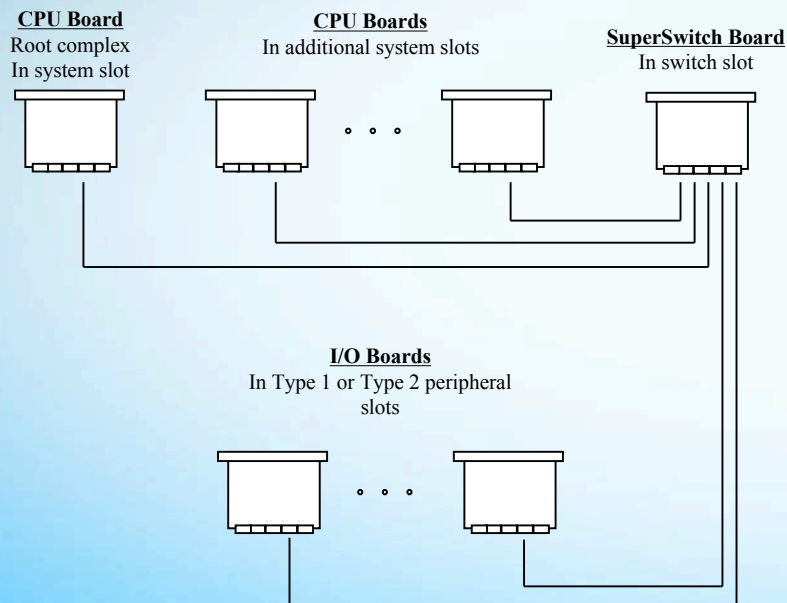
- Two slot wide PCIe x4 board set
- Four external x4 connectors
- x8 Gen 2 version will follow

# More than 5-port Solution



- Based on new 1U SuperSwitch™
  - NT ports in switch
  - Root complex CPU in switch
- Allows other CPUs to utilize generic PCIe over cable interface boards
  - Lower cost
  - Higher performance
  - Available in more form-factors

# CompactPCIe Backplane System with SuperSwitch™

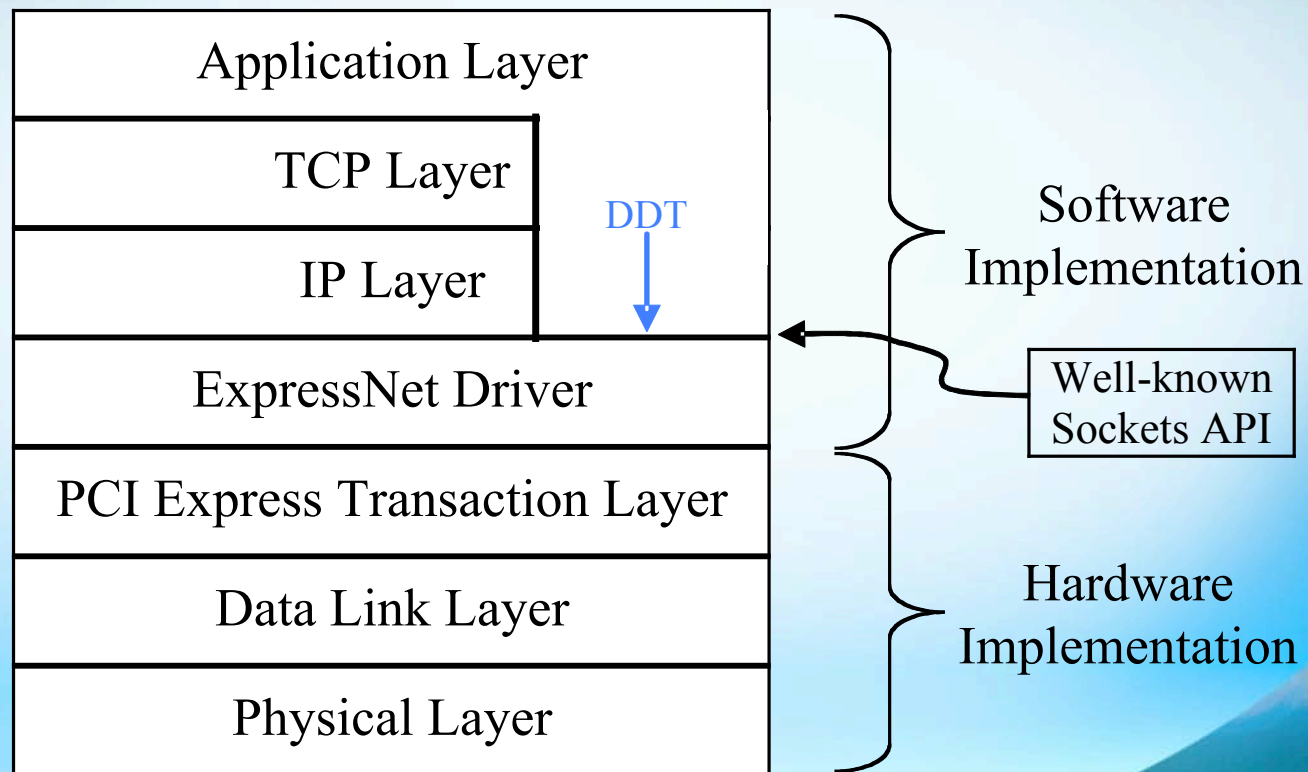


- Based on new CPCle SuperSwitch™
  - NT ports in switch
- Root complex CPU in separate system slot
- CPCle CPU and I/O boards are used unchanged
- Consolidates backplane interfaces into one unified architecture
  - PCIe used for both CPU-to-I/O and CPU-to-CPU communications
- SuperSwitch™ easily ported to other backplane form factors

# ExpressNet Software

- Initialization and fabric management S/W
  - Runs on root complex CPU
  - Sets up network and manages hot-swap events
- ExpressNet Driver S/W
  - Runs on each peripheral CPU
  - Configures NT bridges
  - Two software interfaces
    - Direct data transfer
    - TCP/IP
- Demo program that verifies H/W setup and validates system performance

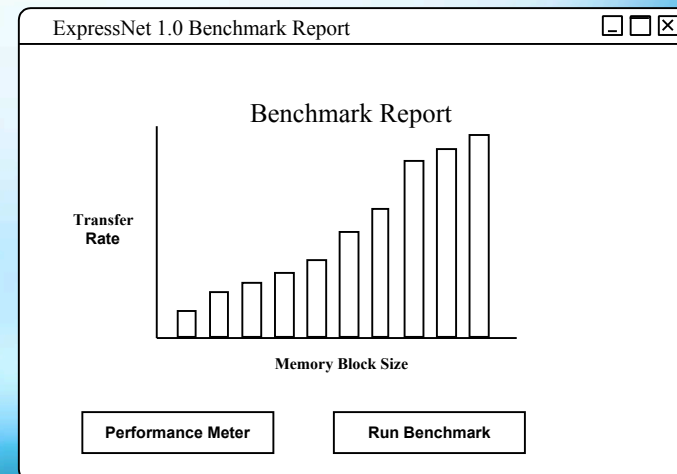
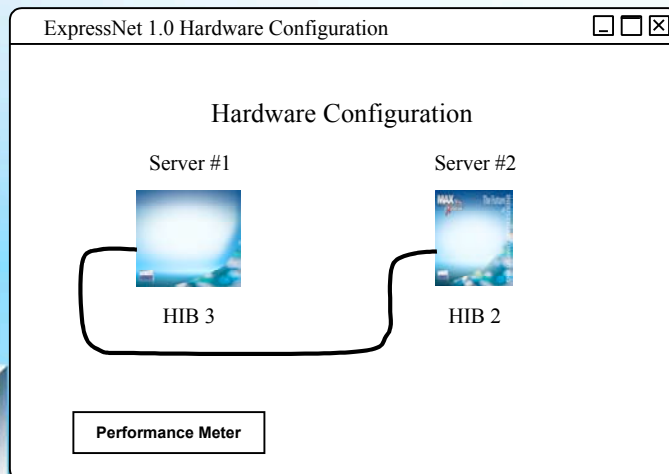
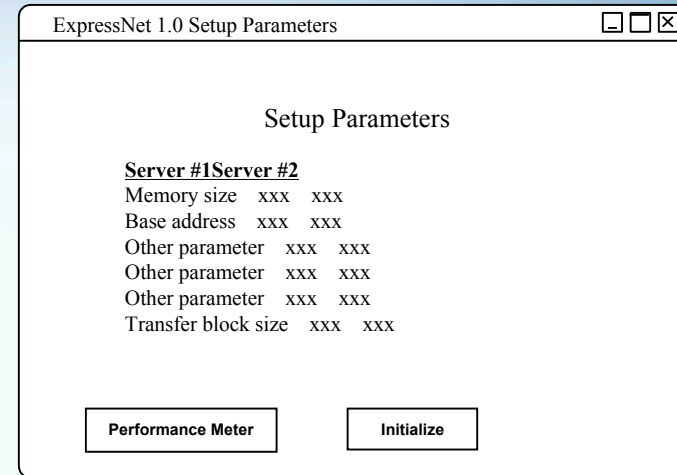
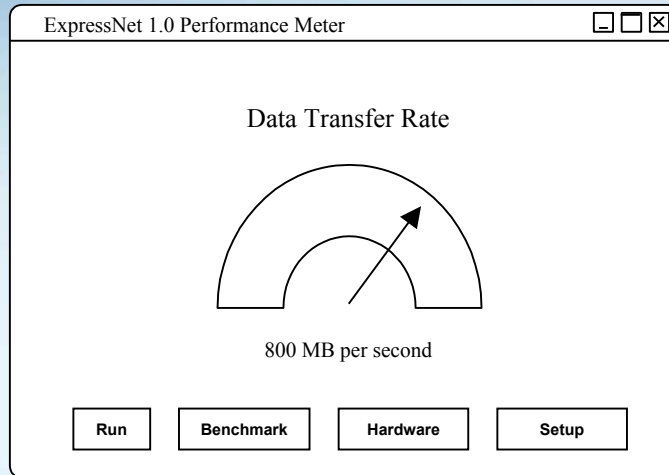
# ExpressNet OSI Model



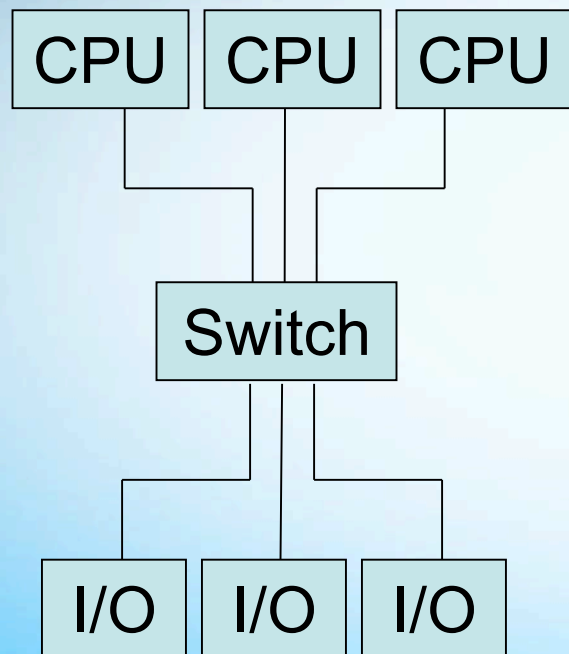
# ExpressNet Release Phases

- Phase I
  - Supports 2 system solution
  - Linux OS only
  - Demonstration program
  - Direct data transfer support
- Phase II
  - Supports dual and multi-node solutions
  - DDT and TCP/IP support
  - Linux OS only
- Phase III
  - Supports dual and multi-node solutions
  - Linux and Windows Oss
  - Adds advanced features

# Phase I ExpressNet Release



# Summary

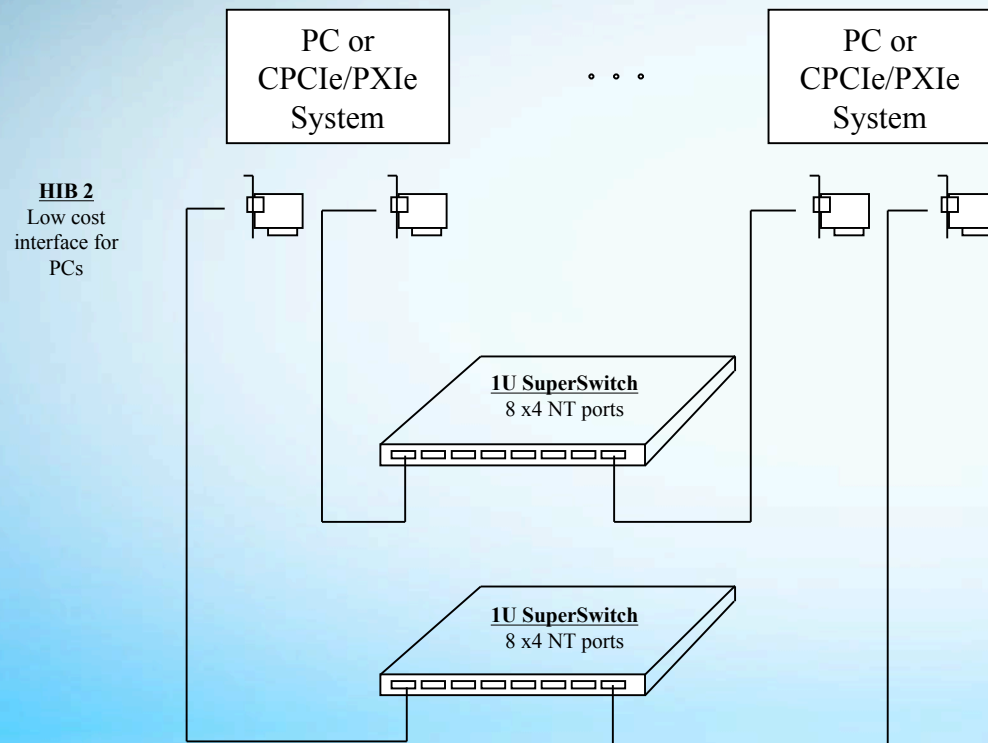


- ExpressNet allows multiple CPUs to communicate over PCIe
- High performance and low cost
- Runs over cabled and backplane systems
  - Provides bus unification in backplane systems
- Supports hot-swap and system redundancy

# Hot Swap Capabilities

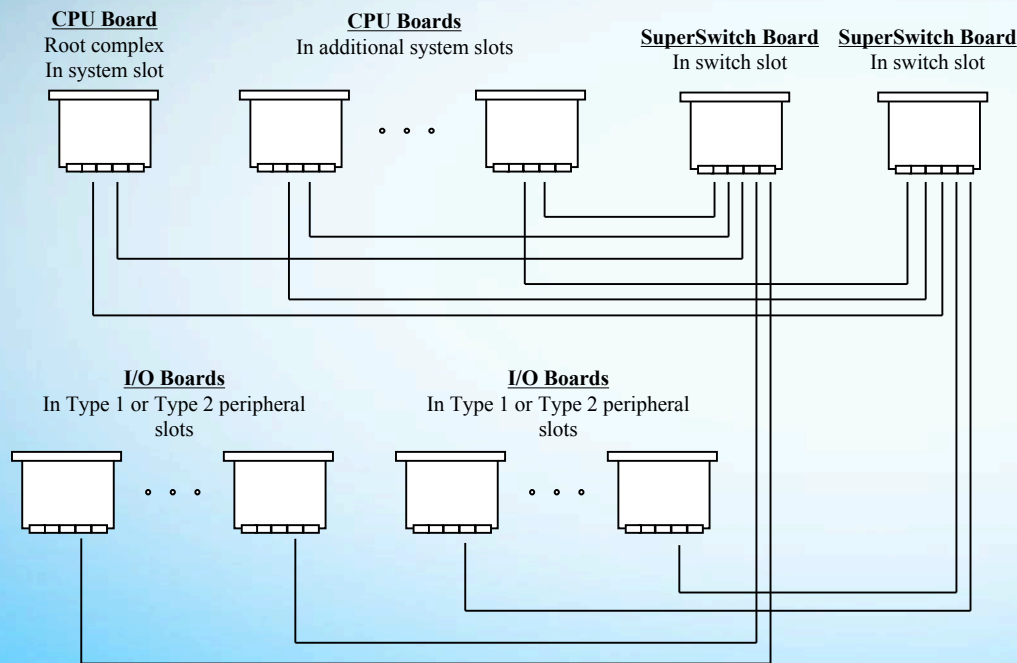
- In cabled systems
  - Any node can be connected or disconnected while the other nodes are running
- In backplane systems
  - Any board may be inserted or removed while the system is running
- Fabric manager software running on root complex CPU
  - Detects insertion or removal of new hardware
  - Notifies nodes of fabric changes
  - Reconfigures NT ports as needed

# Redundant Cabled System Architecture



- Two SuperSwitch 1U units can be used to provide redundant switching
- Each PC or CompactPCIe system needs to include two PCIe over cable interface boards

# Redundant Backplane System Architecture



- Two SuperSwitch CPCle switch boards can be used to provide redundant switching
- All CPCle CPU boards include multiple PCIe ports
- Most off-the-shelf I/O boards support only a single PCIe port so can only be connected to a single switch
  - Custom I/O boards could be designed with two PCIe ports
- The CPCle backplane needs to be designed to support this architecture

# ExpressNet Software – Direct Data Transfer

- Low latency, low overhead protocol
- Well-known sockets API
- Simple protocol to move data

# ExpressNet Software – TCP/IP

- TCP/IP fits above the ExpressNet driver
- Convenient, interface looks like NIC card
- Enables many network features

# ExpressNet Software – Details

- Uses linked chain of buffers
- Descriptors define buffers and data structures
- Polled or interrupt driven
- Primarily uses PCI writes for efficiency