AXIe: AdvancedTCA® Extensions for Instrumentation and Test

AXIe for Physics

ADLINK Technology, Inc.
Aeroflex Corporation
Agilent Technologies, Inc.
Giga-tronics Incorporated
Guzik Technical Enterprises
Test Evolution Corporation

AXIe

AXIe Standard: What and Why

- ## What is it?
  - □ A next-generation, open standard that extends Advanced Telecom Computing Architecture (AdvancedTCA®) for general purpose and semiconductor test

- ## Why another modular test standard?
  - □ Higher performance per rack inch
  - □ Greater scalability
  - □ Integrates easily with PXI®, LXI® and IVI®
  - □ More modularity, more flexibility, higher speeds => addresses a range of platforms
    - • ATE Systems, rack-and-stack modular, bench top, module plug-ins
  - □ Significant reduction of development and unit costs

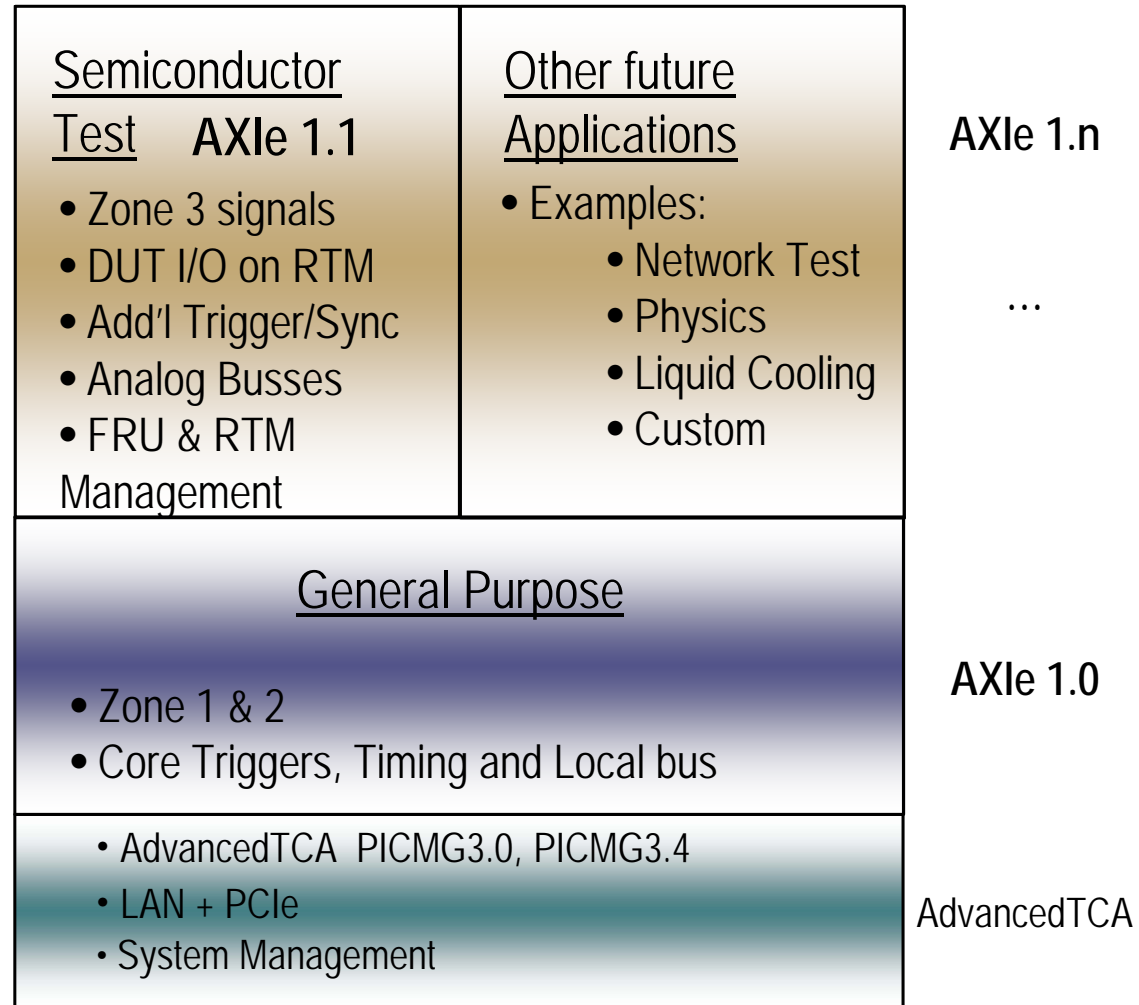**AXIe**

Why AdvancedTCA as a Foundation?

- AdvancedTCA PICMG® 3.0 Standard
  - Proven open system architecture
- Large board size
  - Ideal for high performance instrumentation
  - Board size matches that of planar instrument design
- Rack space efficiency
  - Horizontal and vertical configurations
- Scalability
  - 1 slot to 14 slots, 1 Chassis to many, PXI/PCI adapters
- Ideal for high power applications
  - Single rail power management and robust cooling
- Virtual LXI and PXI
  - Base fabric support of LAN and PCIe data fabric support
- Robust system management
  - Intelligent Platform Management Interface (IPMI) enables both single chassis and multi-chassis system control functions
- Extensions
  - For I/O, custom backplanes, liquid cooling

PICMG is a registered trademark of the PCI Industrial Computer Manufacturers Group.

AXIe

AXIe Standard Structure

AXIe is a scalable standard allowing a portfolio of applications, all of which can leverage general purpose instrumentation.

- Extensions built for specific applications
- Accepts all AXIe 1.0 modules
- Can define specific Zone 3 and additional System Management and system resources.

- Frugal use of AdvancedTCA resources
- Zone 3 unused to allow compatibility with extended uses and existing AdvancedTCA modules
- Allows carrier boards
- Core system management

Semiconductor Test AXIe 1.1	Other future Applications	AXIe 1.n

• Zone 3 signals
• DUT I/O on RTM
• Add'l Trigger/Sync
• Analog Busses
• FRU & RTM Management
	• Examples:
	  • Network Test
	  • Physics
	  • Liquid Cooling
	  • Custom
		…

General Purpose

- Zone 1 & 2
- Core Triggers, Timing and Local bus

AXIe 1.0

- AdvancedTCA PICMG3.0, PICMG3.4
- LAN + PCIe
- System Management

AdvancedTCA

AXI 1.0 and AXI 1.n refer to standards, not revision numbers
Revisions handled as Revision X.Y

AXIe

Requirements of Physics Applications
..and how AXIe meets the needs

- Range of Modules
  - Wide variety of COTS (Commercial Off The Shelf) modules will become available
  - Open system allows custom module development
- Performance density
  - Board footprints provide space for high performance signal conditioning and sensing
  - High power/cooling capacity for high-performance analog and digital subsystems
- Multi-module synchronization
  - AXIe trigger buses
  - AXIe Star trigger, sync, and clock resources.
  - AXIe Local Bus for high speed module to module communication
- Processing power
  - AXIe form factor suitable for high-performance computer and signal processing modules.
  - High power/cooling capacity for high-performance digital subsystems.
  - PCIe fabric provides high-bandwidth IO to/from processors.
  - Cabled PCIe provides link to external high-performance processors.

Requirements of Physics Applications

- Incorporation of custom modules
  - Open, modular system easily accommodates custom module development.
  - Large existing AdvancedTCA ecosystem of basic infrastructure components.
- High throughput data transfers
  - LAN and x4 PCIe for primary control and data transfer.
  - Hub 2 star for custom subsystem communications.
  - AXIe local bus for high-speed streaming between adjacent modules.
- Reliability
  - Mature AdvancedTCA infrastructure developed for high availability applications
  - COTS modules and mainframes developed to traditional T&M quality standards.
- Scalability
  - Modular structure
  - Variety of mainframe configurations
  - Easy migration from PXI
- Cost per channel and TCO
  - Wide selection of COTS components
  - Provides up-scaled solutions from smaller PXI systems.

Why AXIe for Multichannel Applications?

- **Multichannel Performance**
  - Performance Density
    - Power, board area and cooling for channel density and powerful processing
  - Cross-module synchronization
    - Timing
    - Star trigger
    - Local Bus
- **System up-time**
  - AdvancedTCA infrastructure designed for telecom uptime, optional for AXIe
    - Optional backup power for chassis
    - Optional backup cooling for chassis
   - Hot-swap capability optional for AXIe modules and chassis

AXIe

AXIe compatibility With AdvancedTCA

- Full zone 1 compatibility
  - Power distribution
  - System management
- Zone 2 base and fabric compatibility
  - Dual-star topology
- AdvancedTCA redundancy features are optional in AXIe
- AdvancedTCA zone 2 clock and update channels become the AXIe general purpose bussed timing.
- By limiting chassis to 14 slots (maximum in a 19″ EIA cabinet), pins are freed for advanced timing without backwards compatibility effects for current AdvancedTCA products.

Retask AdvancedTCA P20 pins from slot 15 and 16 support to AXIe 1.0 Timing Generation and Local Bus
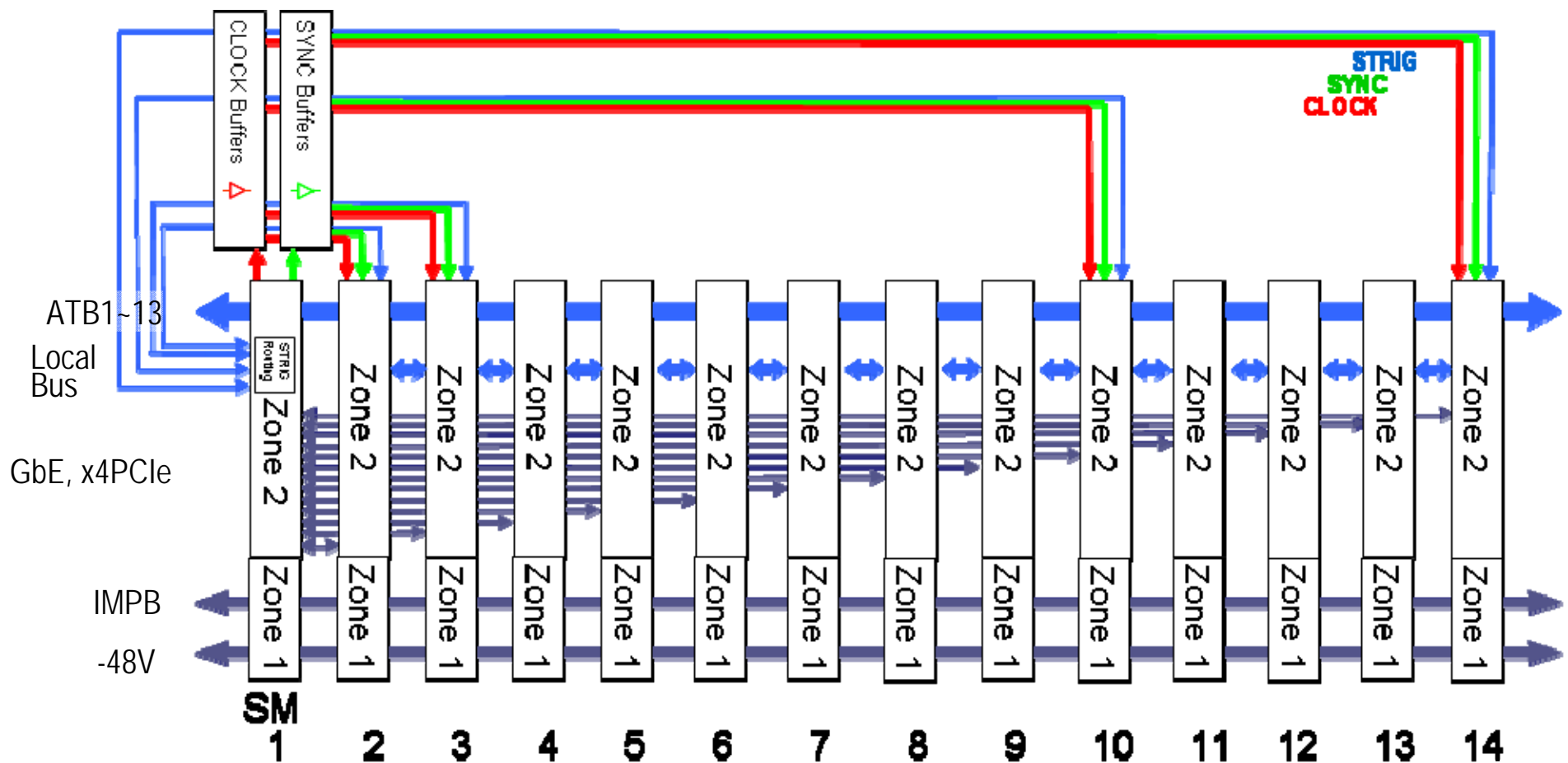
- AdvancedTCA Slots 15 and 16 are unused in 19″ EIA racks (P20 slot 15/16 pins shown below)
- AXIe Timing Bus (ATB) retasks these pins for 100 MHz and star-distributed equal length traces
  - CLOCK, SYNC, and bi-directional STRIG distributed on ATB16-14 to nodes
  - ATB1~13 available for general purpose bussed timing
- Local Bus (LBn) for > 1GHz adjacent node datacomm

J20 rows 1~8

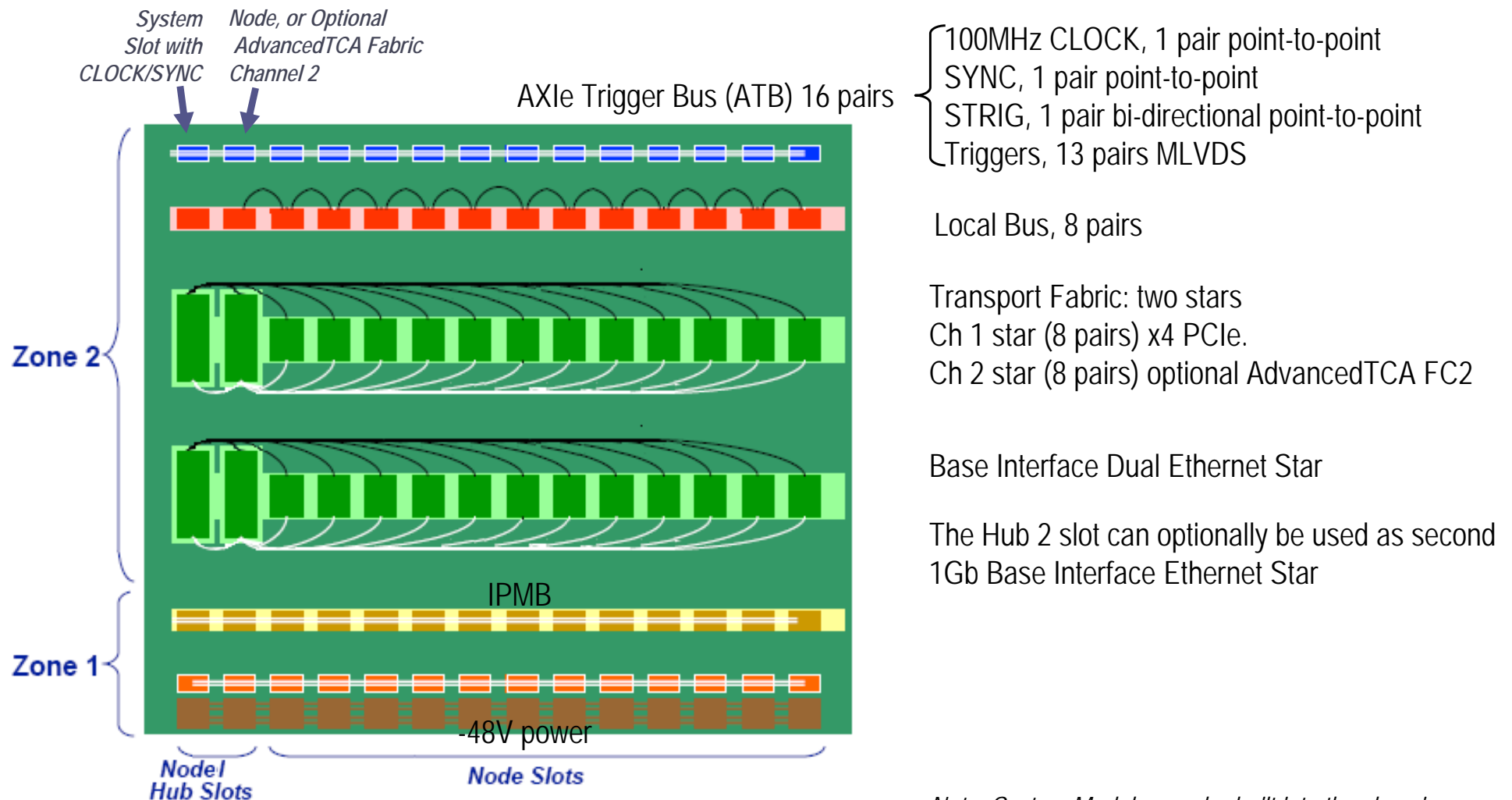| Row	P20 connector pairs							
	ab		cd		ef		gh	
1	ATB1+	ATB1-	ATB2+	ATB2-	ATB3+	ATB3-	ATB4+	ATB4-
2	ATB5+	ATB5-	ATB6+	ATB6-	ATB7+	ATB7-	ATB8+	ATB8-
3	ATB9+	ATB9-	ATB10+	ATB10-	ATB11+	ATB11-	ATB12+	ATB12-
4	ATB13+	ATB13-	ATB14+	ATB14-	ATB15+	ATB15-	ATB16+	ATB16-
5	LBL1+	LBL1-	LBL2+	LBL2-	LBR1+	LBR1-	LBR2+	LBR2-
6	LBL3+	LBL3-	LBL4+	LBL4-	LBR3+	LBR3-	LBR4+	LBR4-
7	LBL5+	LBL5-	LBL6+	LBL6-	LBR5+	LBR5-	LBR6+	LBR6-
8	LBL7+	LBL7-	LBL8+	LBL8-	LBR7+	LBR7-	LBR8+	LBR8-

Zone 2

Zone 1
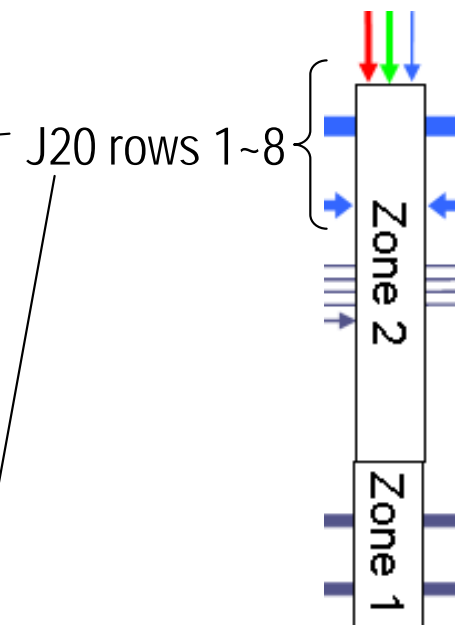
AXIe

AXIe 1.0 Backplane Block Diagram

- CLOCK, SYNC, and STRIG are "star"-ed with equal-length traces from the SM to Node slot
- STRIG is bi-directional and not buffered

AXIe 1.0 Backplane Layout

System Slot with CLOCK/SYNC

Node, or Optional AdvancedTCA Fabric Channel 2

AXIe Trigger Bus (ATB) 16 pairs

100MHz CLOCK, 1 pair point-to-point
SYNC, 1 pair point-to-point
STRIG, 1 pair bi-directional point-to-point
Triggers, 13 pairs MLVDS

Local Bus, 8 pairs

Transport Fabric: two stars
Ch 1 star (8 pairs) x4 PCIe.
Ch 2 star (8 pairs) optional AdvancedTCA FC2

Base Interface Dual Ethernet Star

The Hub 2 slot can optionally be used as second 1Gb Base Interface Ethernet Star

Zone 2

Zone 1

IPMB

-48V power

Node/ Hub Slots

Node Slots

Note: System Module may be built into the chassis
Note: Graphic shows 14 slots as example only

AXIe

AXIe leverages AdvancedTCA

AXIe

AdvancedTCA

- AdvancedTCA specific extensions
- IPMI and resource management
- Timing and Sync
- Zone 3 configurations

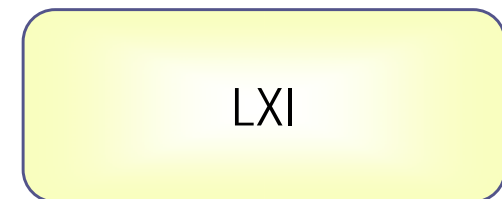# …draws from and works with existing instrument standards

PXI

IVI

LXI
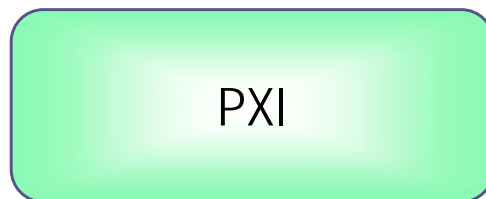
- Virtual PXIe instruments
- PCIe communication

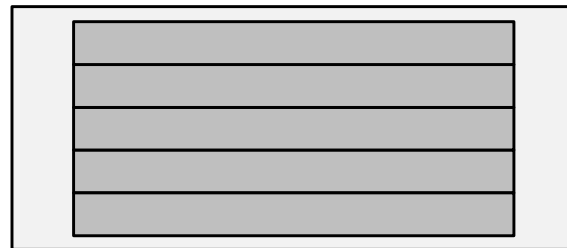- Standard drivers work in all Application Development Environments
- VISA standard

- Virtual LXI instruments
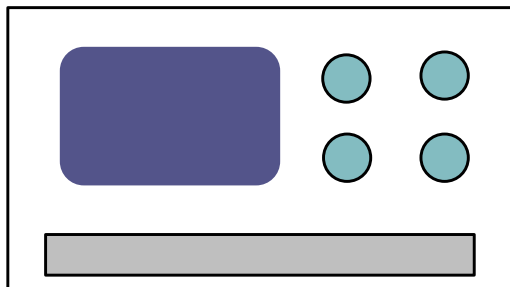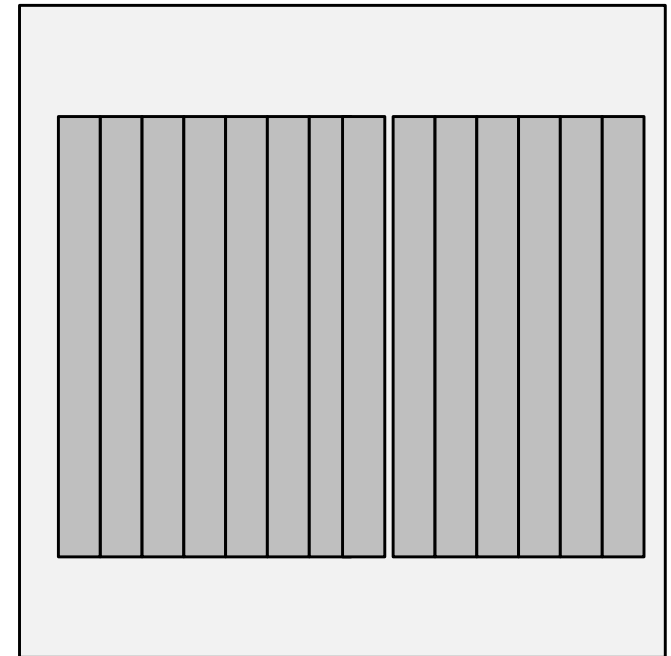- LAN communication
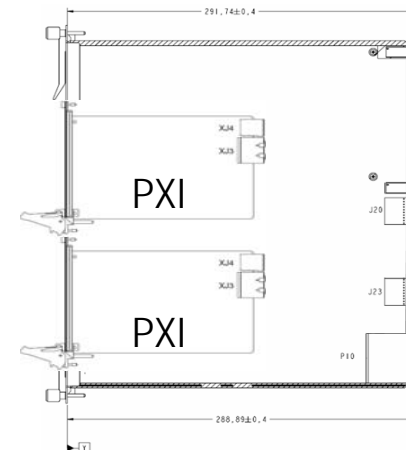
AXIe

High scalability of AXIe

14 slot Vertical

n U Horizontal

1U

Specialty instrument with AXIe module

PXI

PXI

PXI
carrier module

AXIe integration with Rack and Stack

GP-IB Instruments

LXI Box Instruments

GP-IB

AXIe
(LAN and PCIe
on backplane)

LAN

PXI

**Cable
PCIe**

Stand-alone PC

Common control via
- Rack mounted controller, or
- Embedded controller in chassis, or
- Desktop controller
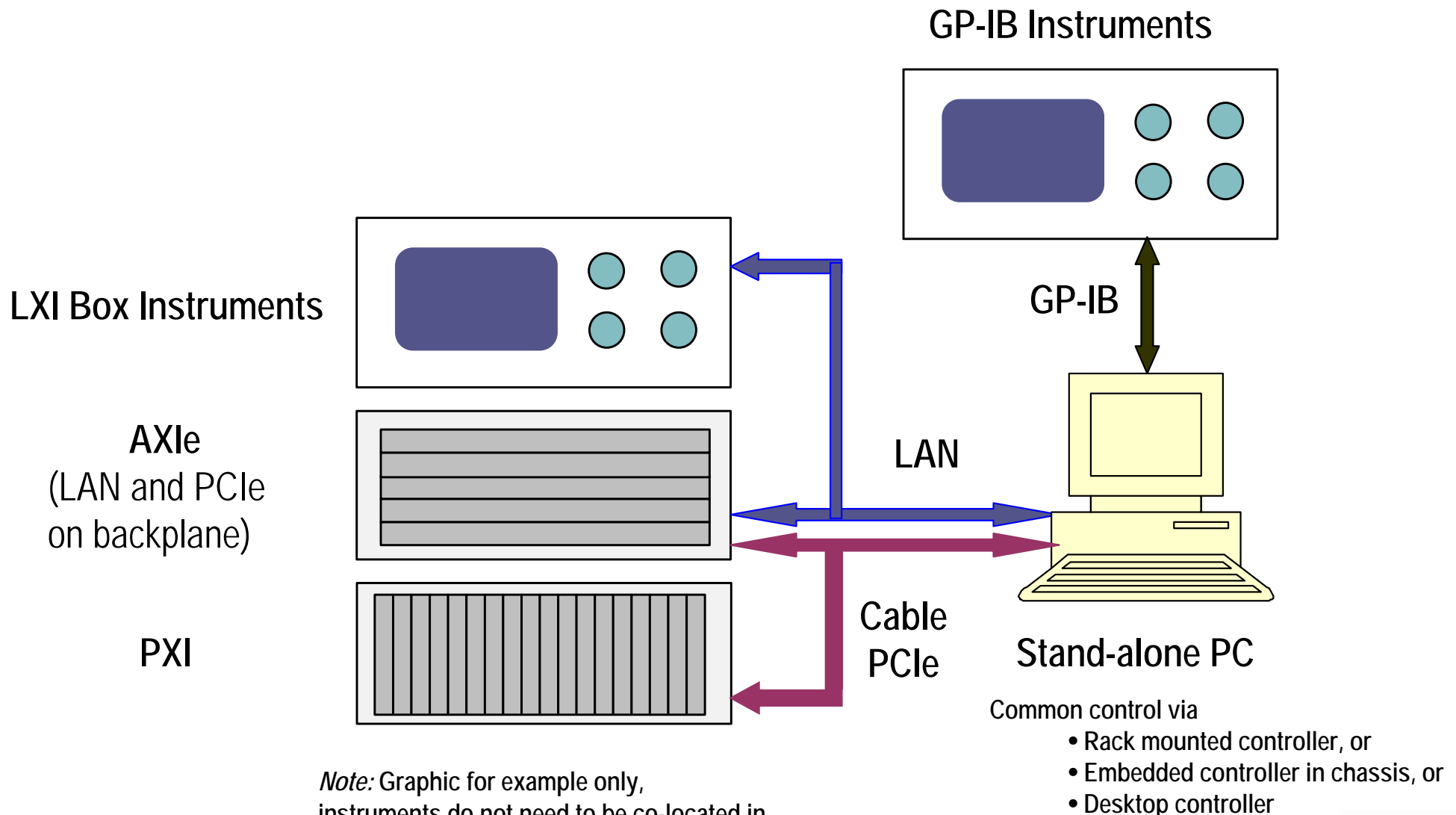
Note: Graphic for example only,
instruments do not need to be co-located in
same rack unit.

AXIe

AXIe is the next logical step in modular instrumentation for physics

AXIe

2010->

AdvancedTCA

2002->

cPCI

1995->

VME
VXS
VPX

VXI

1990->

1980->

FASTBUS

1980-95

CAMAC

1970-90
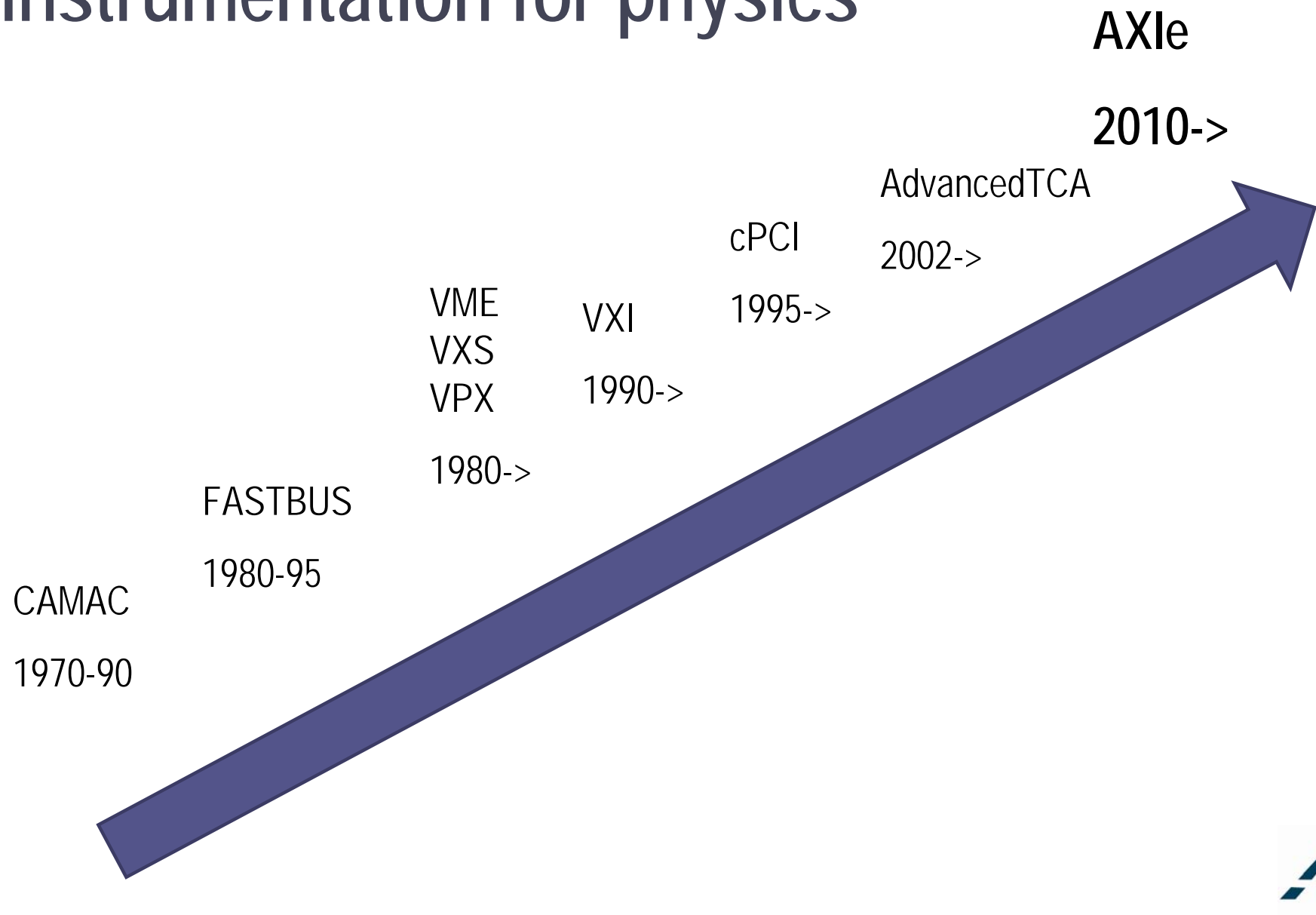
AXIe

Summary

- Extending AdvancedTCA
    - AXIe is based on AdvancedTCA with extensions for instrumentation and test. AXIe uses clever techniques to add powerful timing features while maximizing AdvancedTCA backwards compatibility.
- More Performance, Scalability, Flexibility
    - AXIe delivers high performance and density in a flexible, scalable platform.
- Ideal for customized modules
    - AXIe offers the power, cooling and board area for custom designs, while allowing users to leverage standard infrastructure components.
- PXI, LXI, IVI
    - AXIe works well with other standards, such as PXI, LXI and IVI.
- Longevity
    - Promises longevity due to high performance coupled with layered standards