

# AXIe : AdvancedTCA® Extensions for Instrumentation and Test

## Autotestcon 2016

**COBHAM**

**KEYSIGHT**  
TECHNOLOGIES

**Giga-tronics**

**TEV**  
testevolution.com

**X**  
**COM**  
A Bird Technologies Company

**ADLINK**  
TECHNOLOGY INC.

**GUZIK**  
Technical Enterprises

**Modular**  
**Methods**

**Anritsu** Discover What's Possible™

**ip**  
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EST

**ELMA**  
Your Solution Partner

**EXOPSIS**  
LABORATORY GROUP

**AXIe**

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# AXIe: What is it?

- An open system modular instrumentation standard based on AdvancedTCA<sup>®</sup>
- that delivers high performance instrumentation
- for wireless comms, aerospace defense, high energy physics, semiconductor test, and other industries.

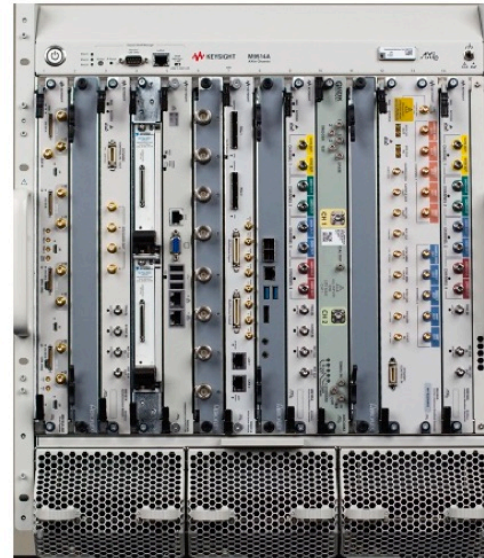
## Multi-vendor AXIe systems



2-slot AXIe system

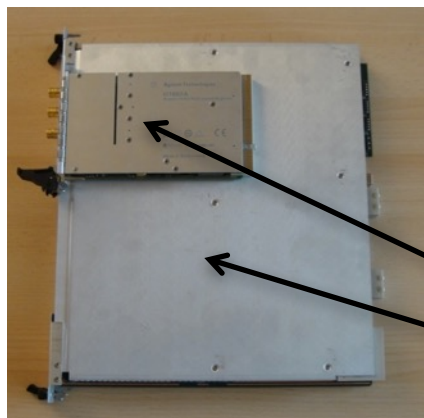


5-slot AXIe system



14-slot AXIe system

# AXIe: Why, what are the advantages?



“Big brother to PXI.”

PXI (30 Watts)  
AXIe (200 Watts)

- Similar PCI Express data fabric, but twice as wide (x16 lanes to each slot)
- Larger and deeper modules (up to 200W per slot)
- Greater power and rack density (typically 2:1 to 3:1 over PXI)
- Scalability from 2-slot to 14-slot systems
- Horizontal configurations for minimal rack space, vertical for large systems
- Hosts the industry's fastest modular digitizers, AWGs, and digital products
- High speed trigger, timing, and local bus
- Integrates easily with LXI, PXI, and VXI using IVI drivers

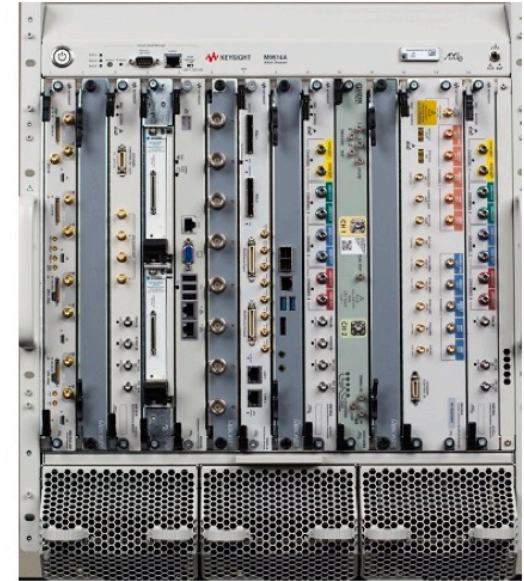
## High scalability of AXle



## 2-slot AXle system



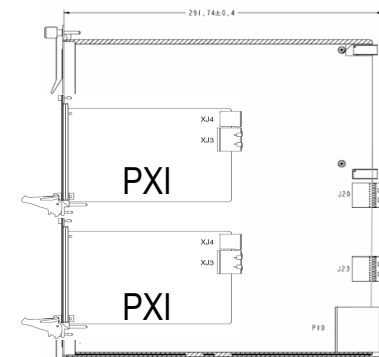
## 5-slot AXle system



## 14-slot AXle system



## Specialty instrument with AXle module



PXI  
carrier  
module

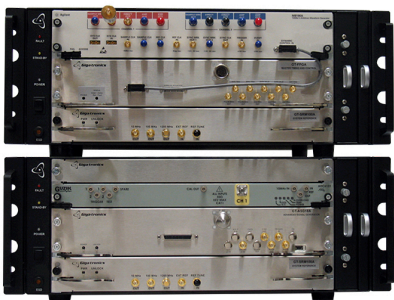




# Multi-vendor:

Today, AXIe products may be mix-and-matched from 8 vendors:

Giga-tronics EW threat simulator



- Giga-tronics
- Elma Electronic
- Guzik
- Keysight

Informtest AXIe-0  
Electronic Switching



Test Evolution AXIe-3.1  
Semiconductor Test  
(plus PXI)



Numerous AXIe-1 modules and systems from:

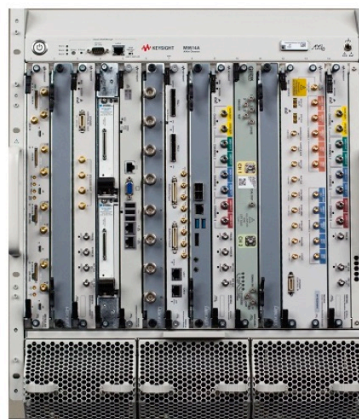
- Cobham
- Guzik
- Keysight
- Synopsys



2-slot AXIe system



5-slot AXIe system



14-slot AXIe system

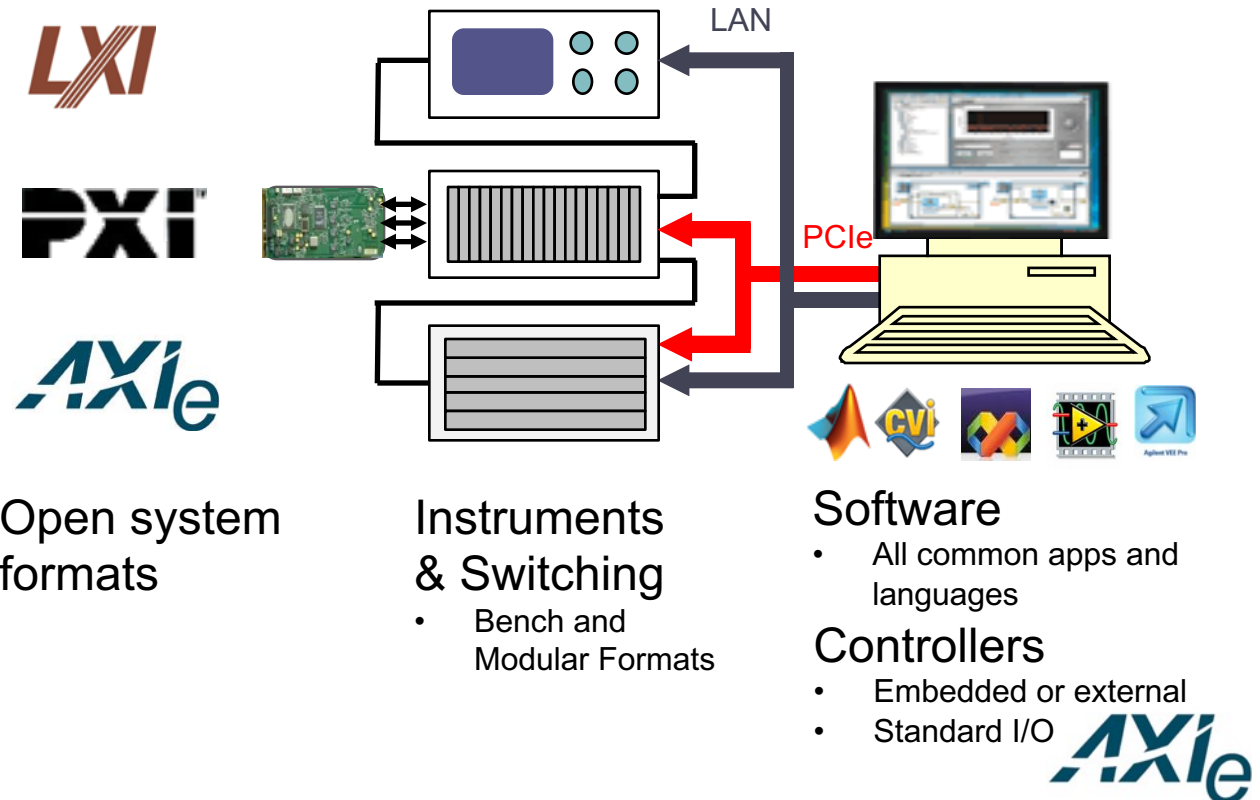


LXI, PXI, and AXIe  
Rack and Stack System

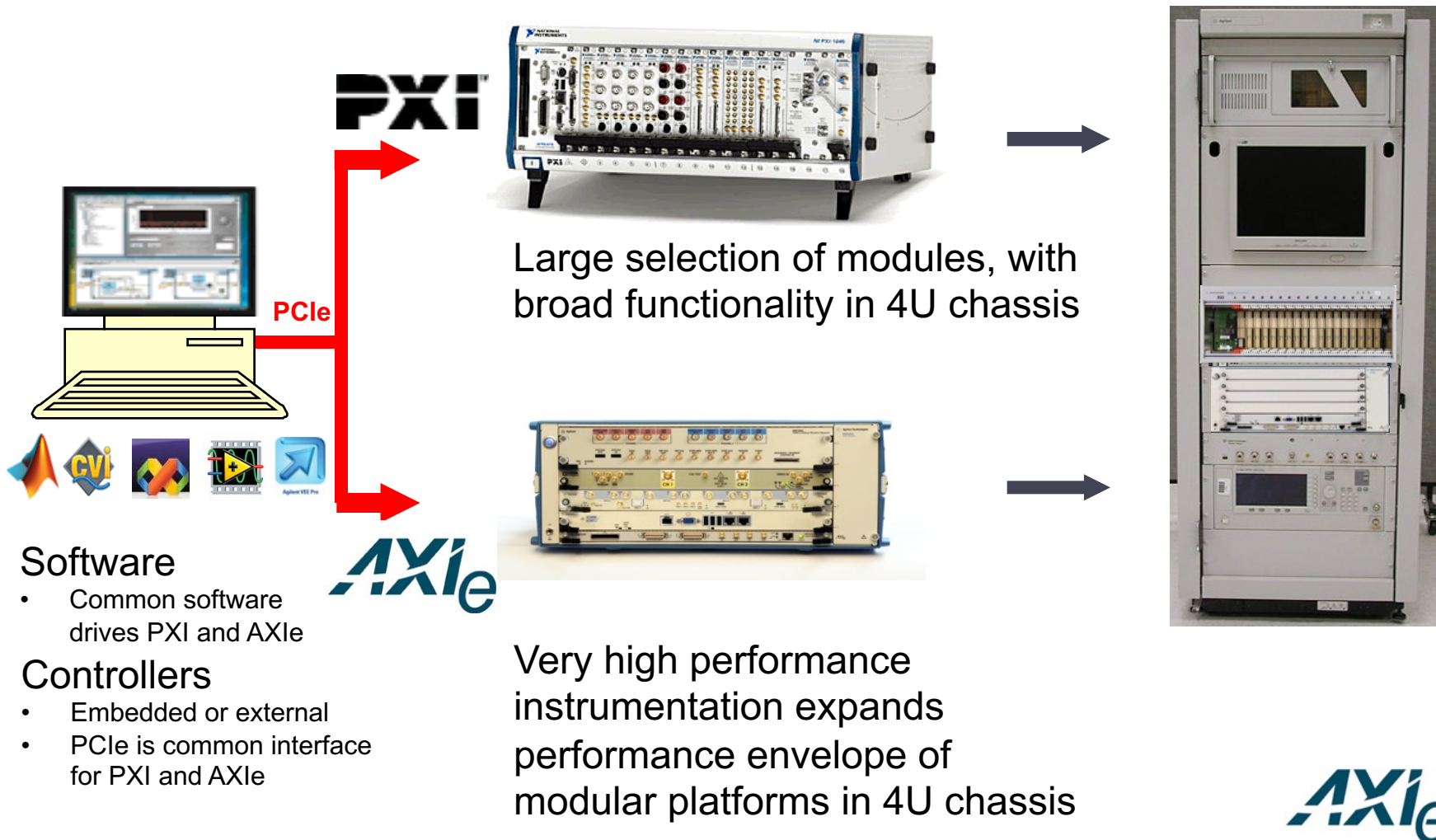


AXIe + PXI  
Semiconductor Test System

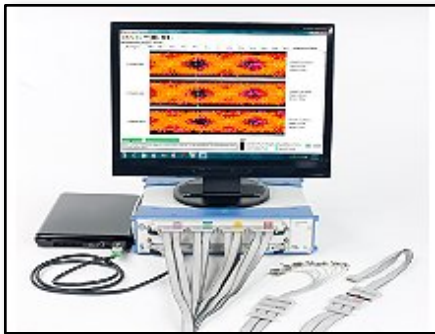
# AXIe can be easily integrated with other instruments in a test system



# AXIe brings critical functionality to Mil/Aero systems in a dense and powerful form factor

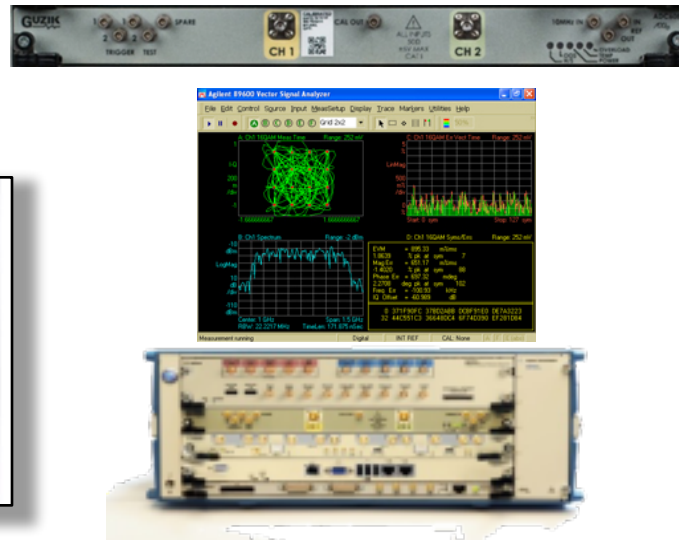


# AXIe brings powerful and cost effective new technology to digital verification and test



AXIe delivers leading edge verification tools including:

- PCIe Gen 1,2,3 exerciser and analyzer
- Industry's fastest logic analyzer
- DDR3/4 analysis



AXIe digitizers and AWGs deliver industry leading performance for mixed-signal test:

- Digitizers range from 1.6Gs/s @12 bits to 40Gs/s @ 8 bits
- AWGs deliver 8Gs/s @ 14 bits to **96Gs/s @ 8 bits**
- 1, 2, 4 and even 32 channels
- Powerful and complex waveform creation and analysis



AXIe + PXI Semiconductor Test System offers cost effective alternative to “big iron” testers for small scale manufacturing and design verification



# AXIe brings world-class measurements and density to Big Physics

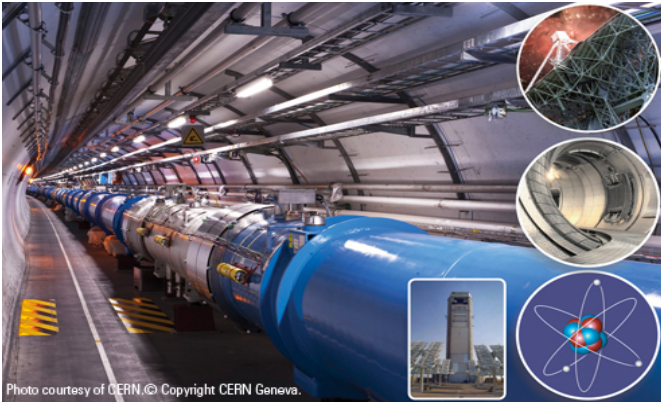
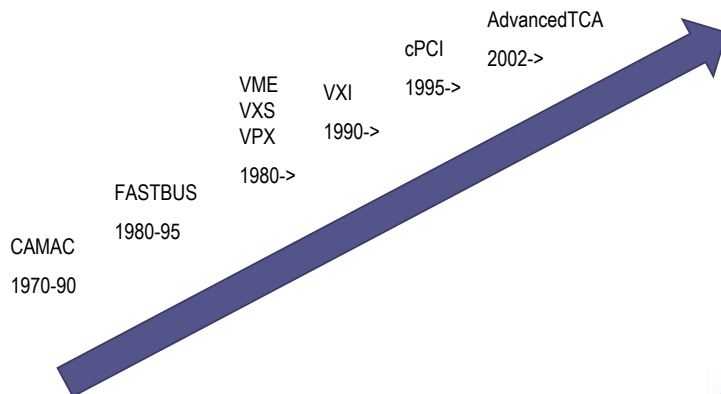


Photo courtesy of CERN. © Copyright CERN Geneva.

AXIe is the next logical step in modular instrumentation for physics

AXIe  
2010->



AXIe digitizers and AWGs deliver industry leading performance:

- Digitizers range from 1.6Gs/s @ 12 bits to 40Gs/s @ 8 bits
- AWGs deliver 8Gs/s @ 14 bits to 96Gs/s @ 8 bits
- Powerful and complex waveform creation and analysis

AXIe brings unprecedented rack density to high speed digitizers – 64 channels, 104 possible!



4U Rack Height:



40 channels of 1.6Gs/s



20 channels of 10Gs/s

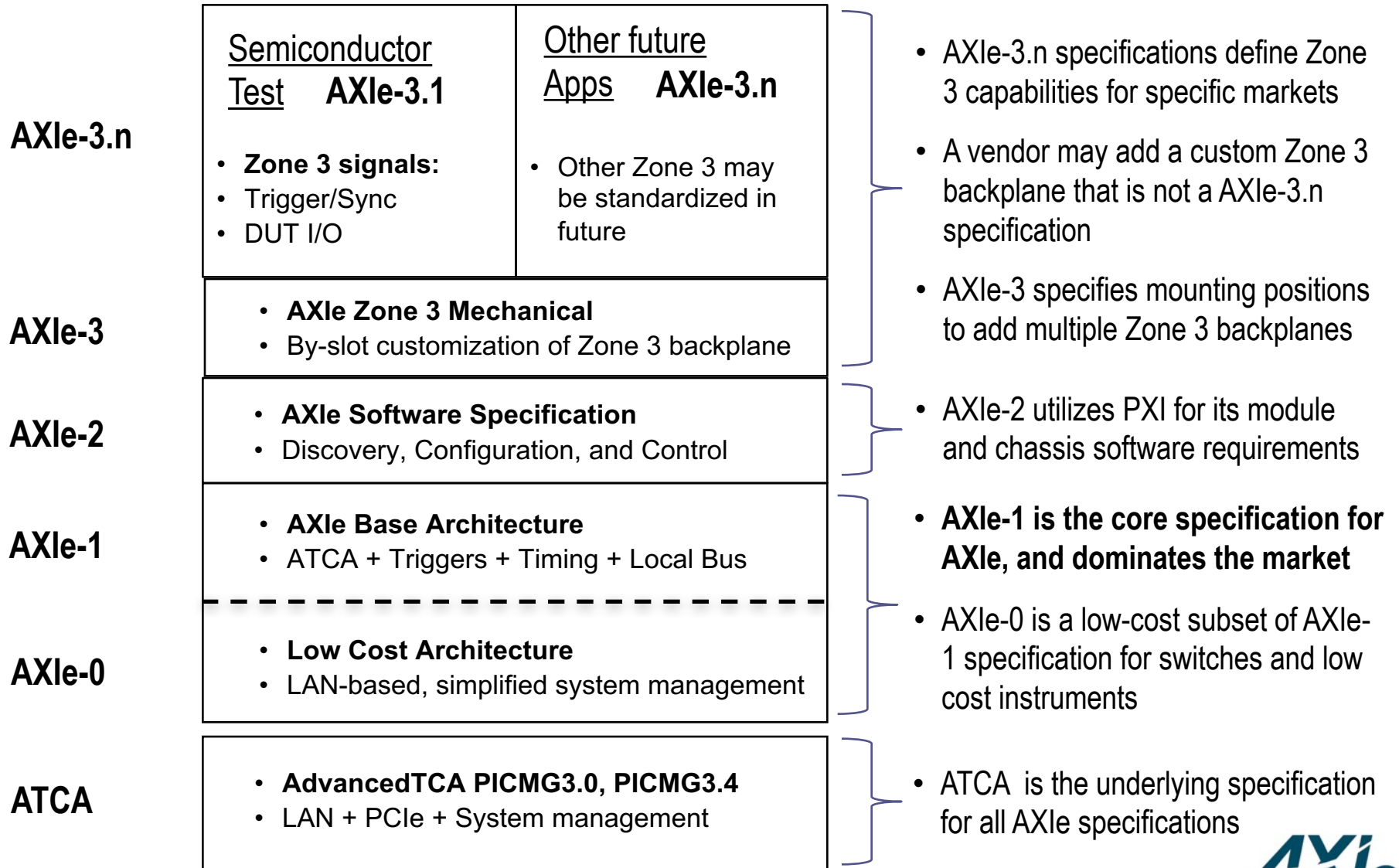


Waveform Capture and Generation

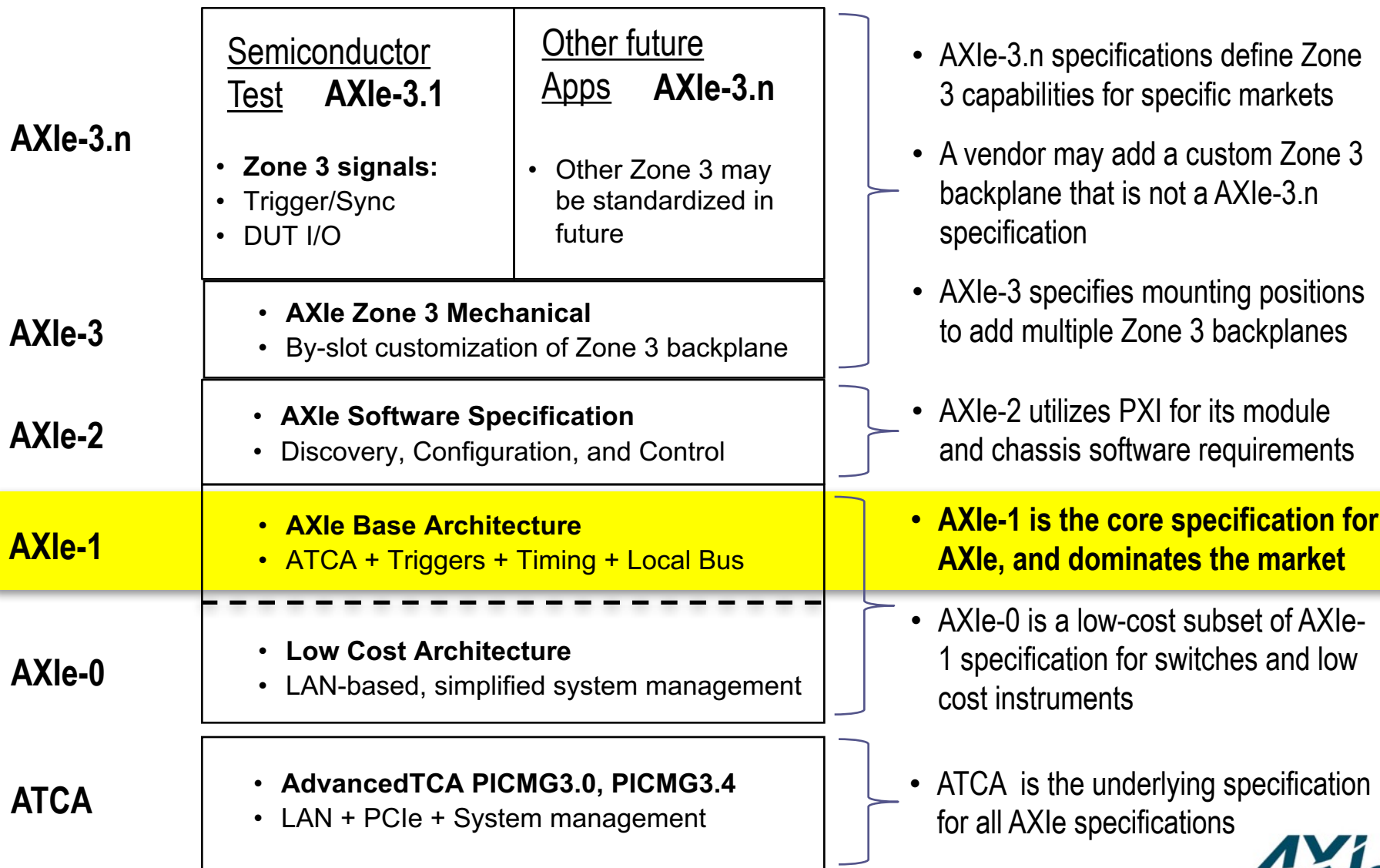
AXIe

AXIe

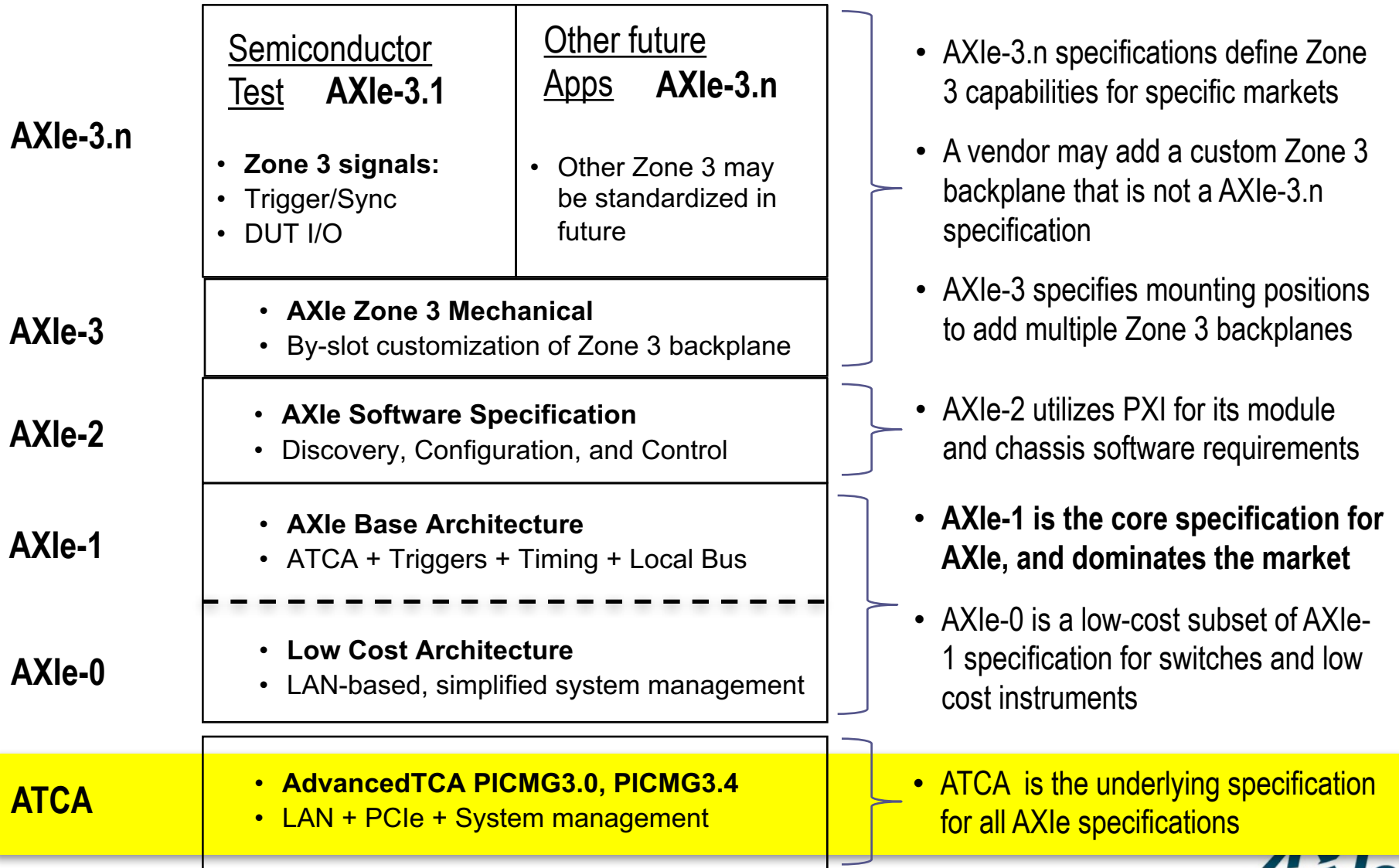
# AXIe Specification Structure



# AXIe Specification Structure



# AXIe Specification Structure





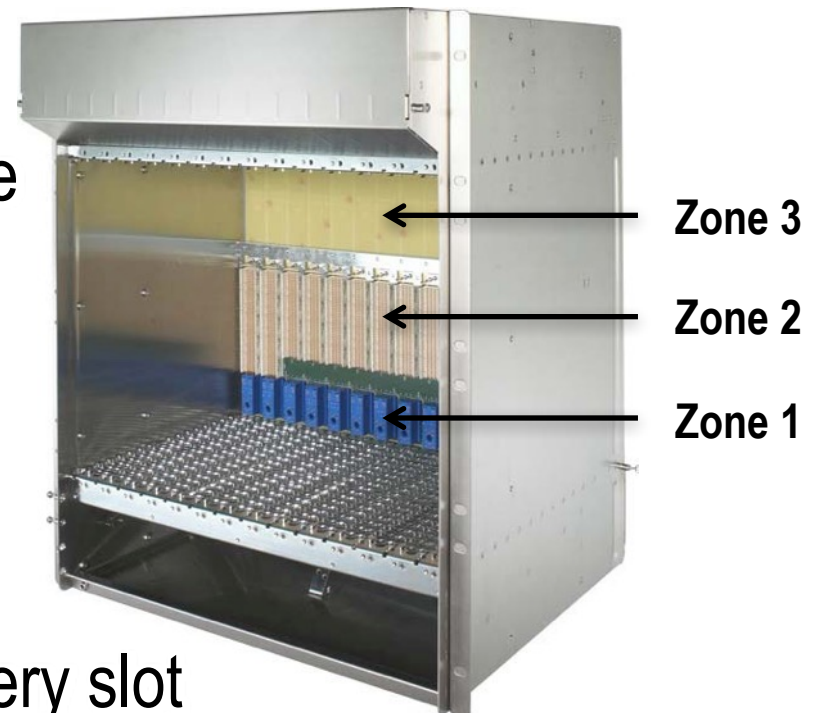
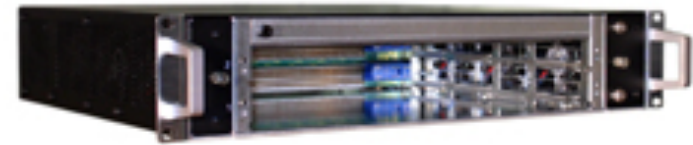
# Why AdvancedTCA as a foundation?

The Advanced Telecom Computing Architecture (AdvancedTCA® or ATCA®) is a series of open standard computing platform specifications originally developed to meet the needs of communications equipment.

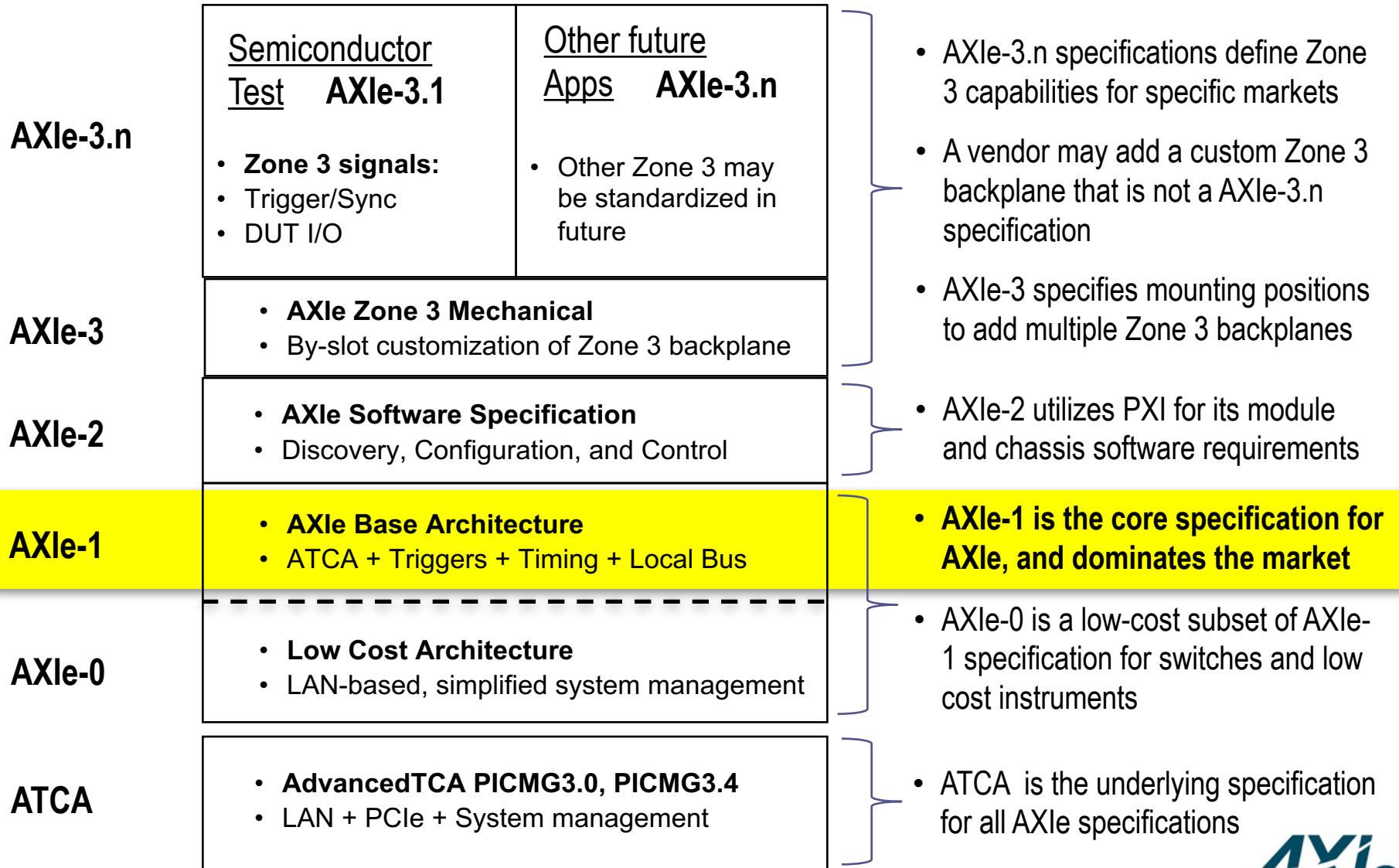
- **Proven open system architecture**
- **Large board size, exceptional power management, robust cooling**
- **Rack space efficiency, horizontal and vertical configurations**
- **Scalability from 1 to 14 slots, 1 chassis to many**

# AdvancedTCA Overview

- 2-14 Slots in 19" Rack
- Zone 1 power (-48V)
- Zone 2 data fabric
- User-defined Zone 3 Backplane
- Large format cards:
  - 280mm deep (11")
  - 322.25mm wide (12.7")
  - 30.48mm slot width (1.2")
- LAN routed to every slot
- PICMG 3.4: PCI Express to every slot
- Flexible power and air cooled design

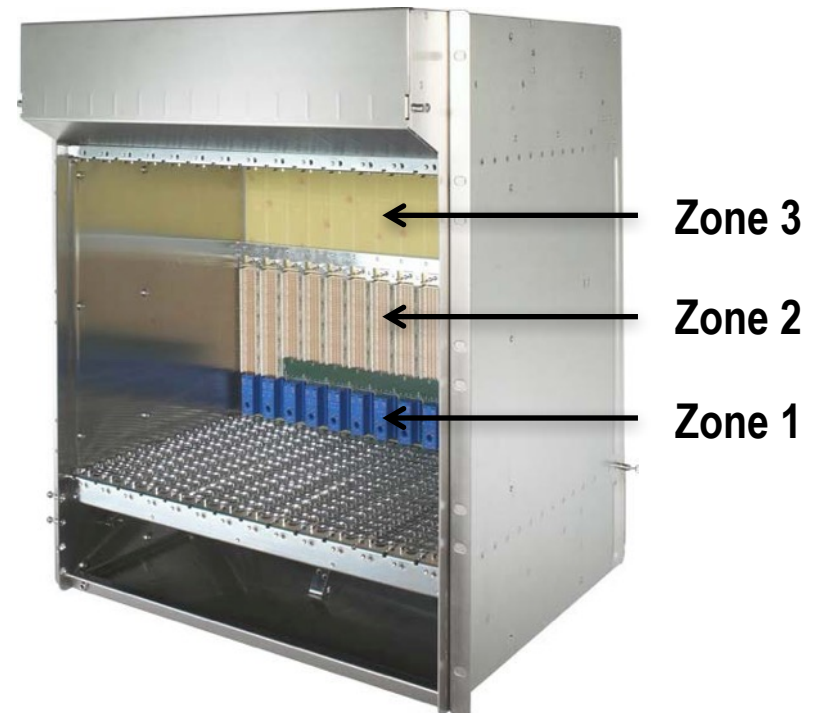
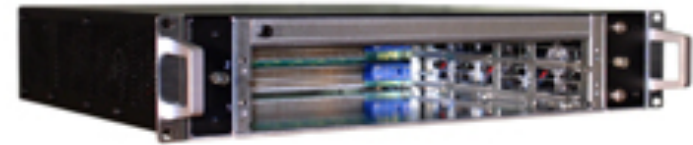


# AXIe Specification Structure



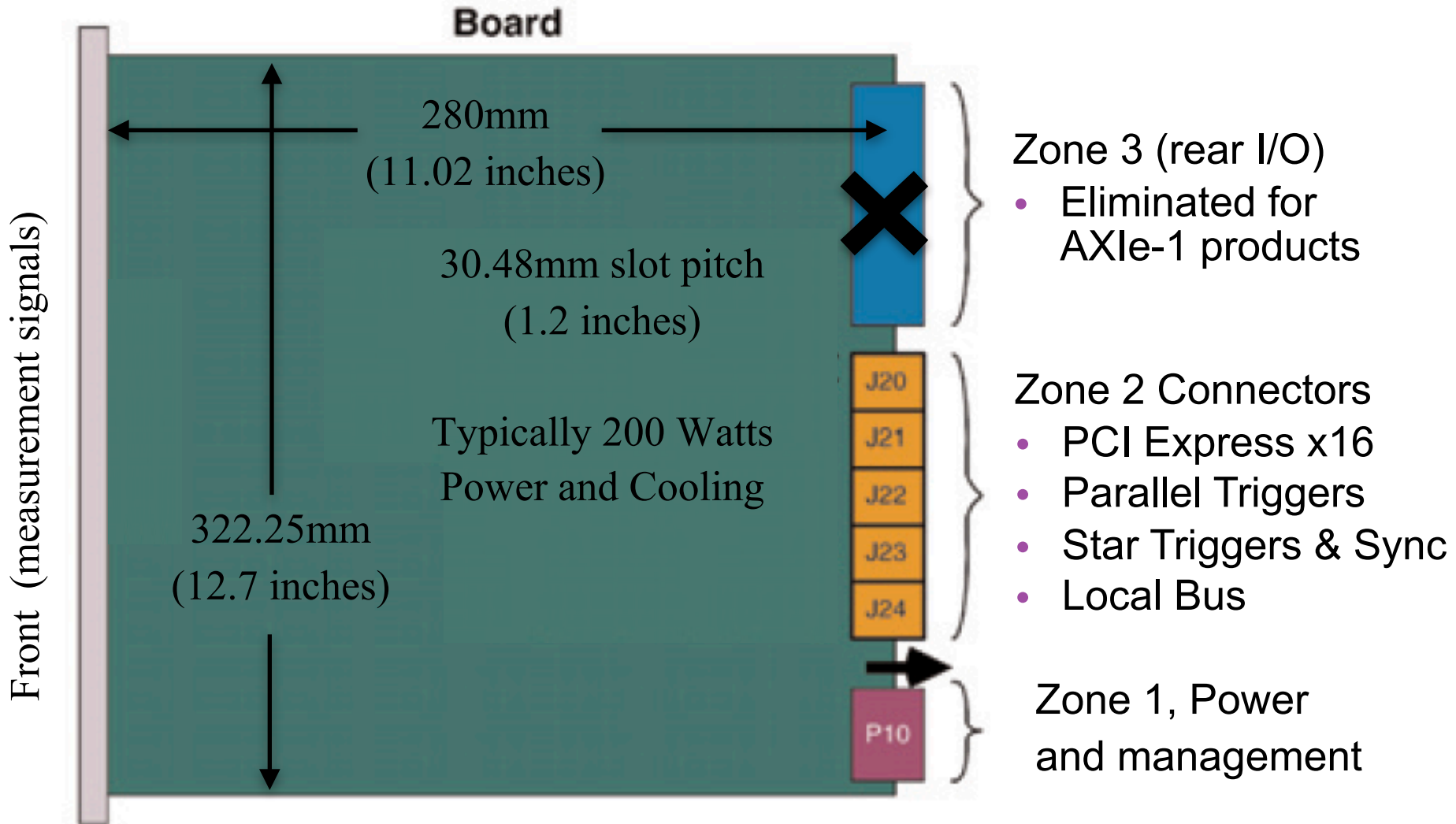
# AXIe-1

- **Leveraged from ATCA:**
  - Same mechanical dimensions
  - Same connector zones
  - Power from Zone 1
  - PCI Express on Zone 2
  - No Zone 3
- **AXIe-1 adds:**
  - Expanded data fabric (x16)
  - Triggers, synchronization
  - Local Bus





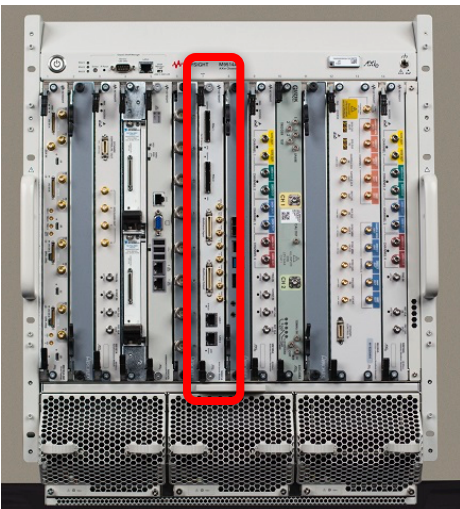
# AXIe-1 Module Characteristics



# AXIe-1 allows the system module to be either be plugged in, or embedded into the chassis:



Chassis with embedded system module (ports not shown, in rear)



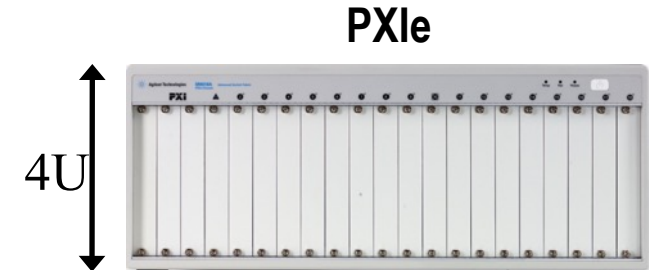
Chassis with pluggable AXIe system module (plugged into center hub slot)

## **AXIe System Module delivers**

- PCI Express interface
  - PCI Express switching
  - LAN Interface
  - Parallel and Star Triggers, Sync, and Clocks.
- 
- Embedded system modules are the most common, but both varieties exist in AXIe.

# Horizontal AXIe compared with PXI

## The tale of two 4U chassis:



Total module volume

$$4500 \times 3 = 13500 \text{ cm}^3$$

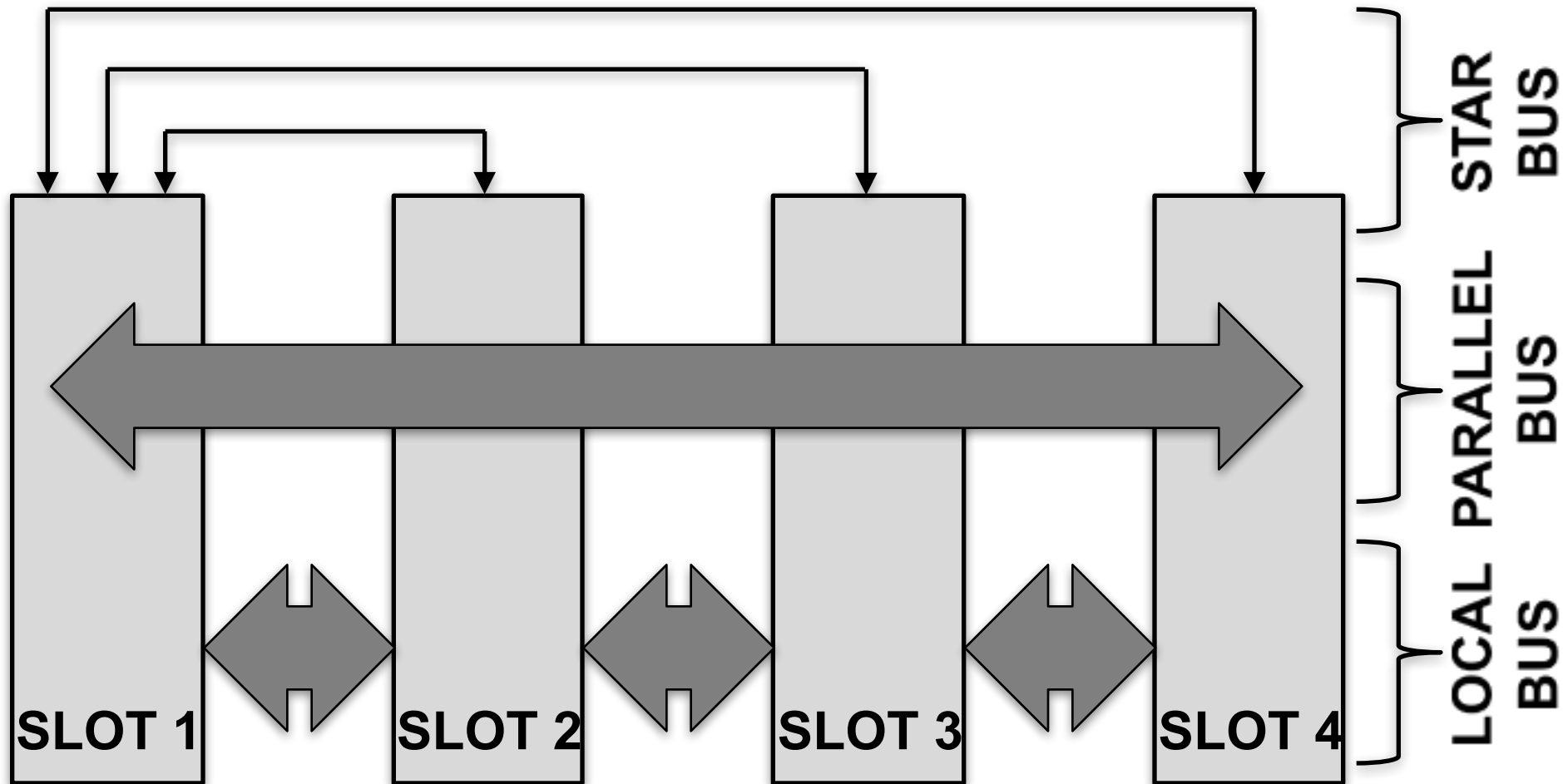
$$2720 \times 2 = 5440 \text{ cm}^3$$

Total module power

$$200\text{W} \times 5 = 1000 \text{ W}$$

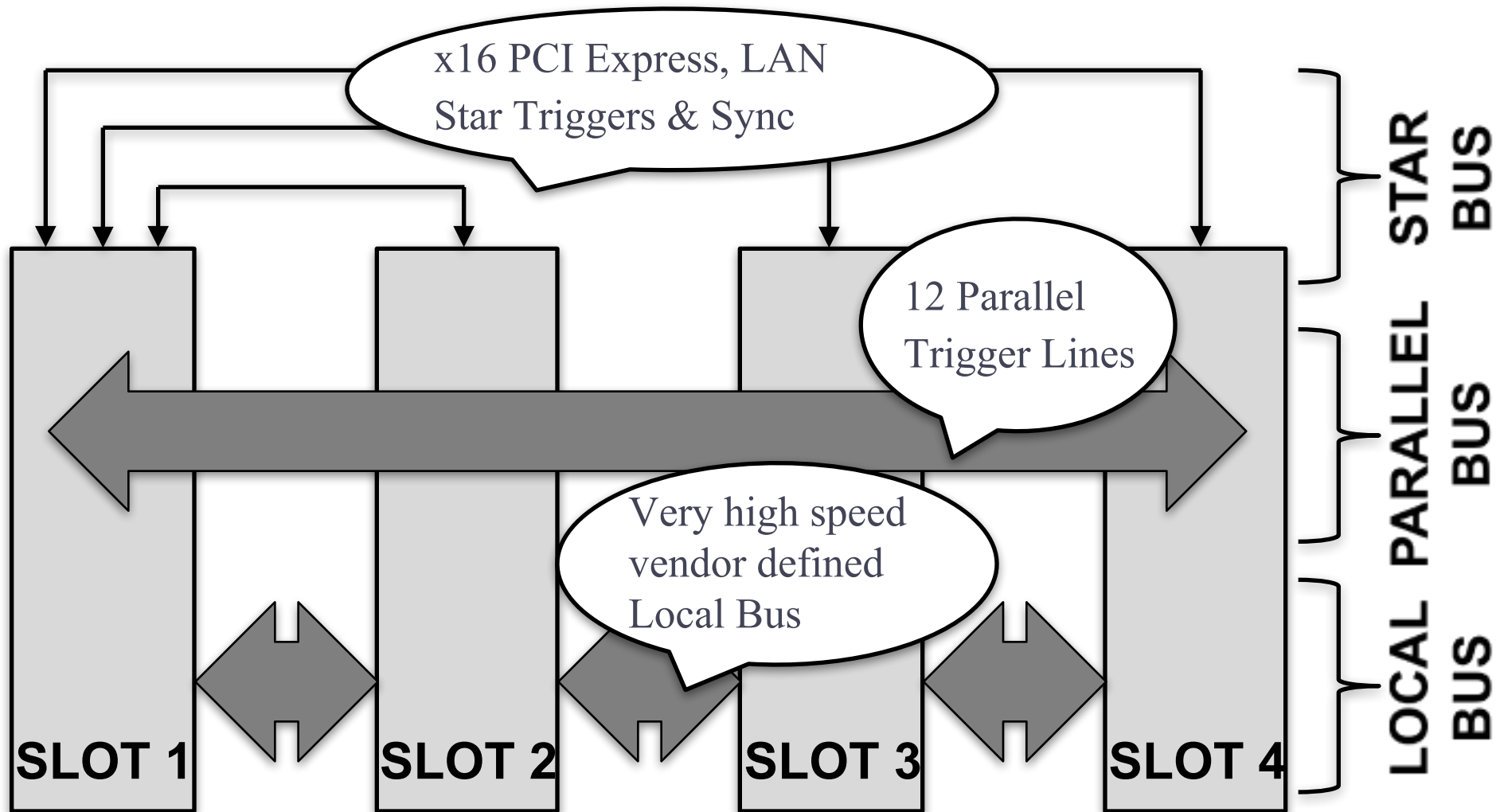
$$17 \times 30 = 510 \text{ W}$$

# AXIe-1 exploits unique bus topologies

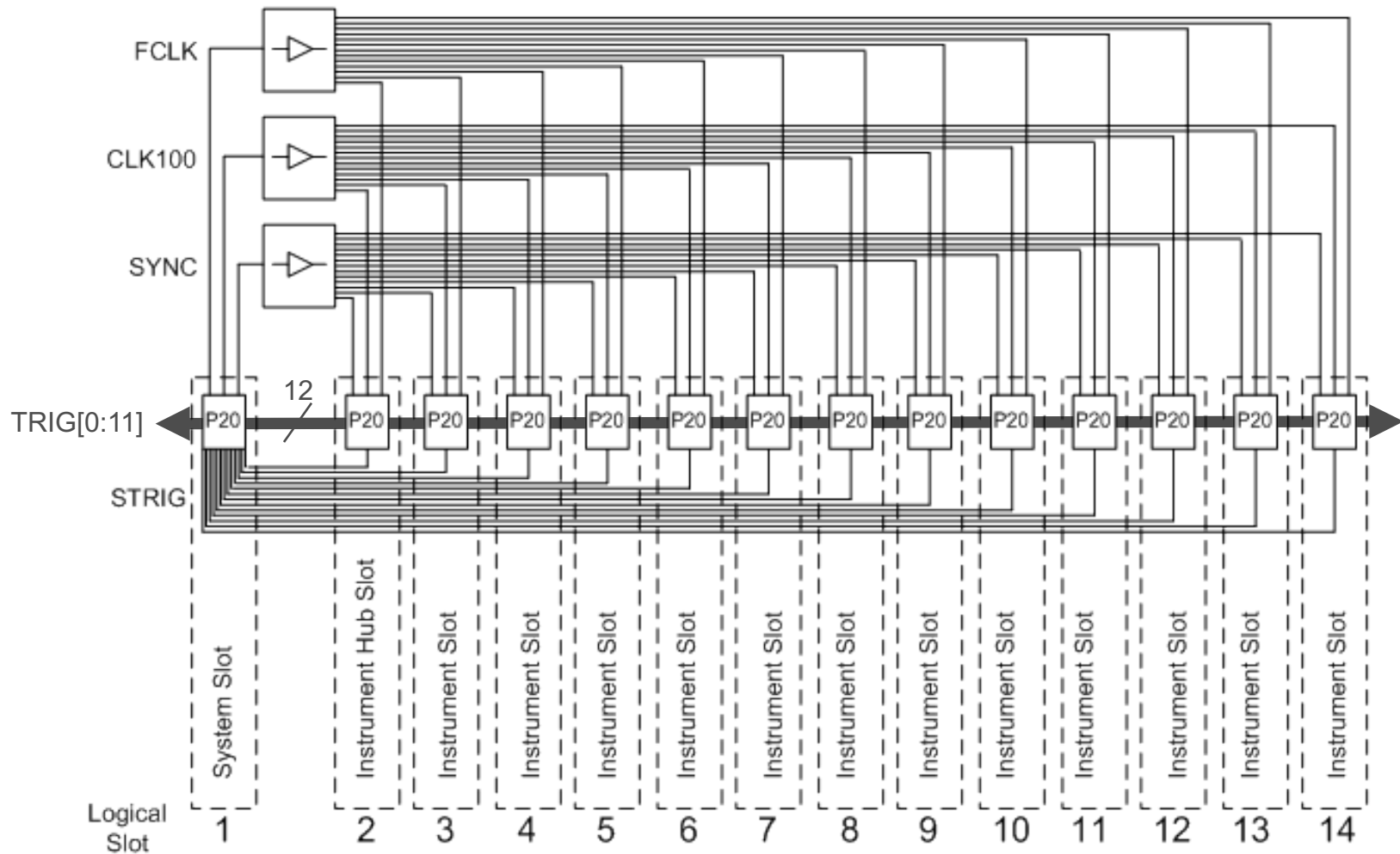




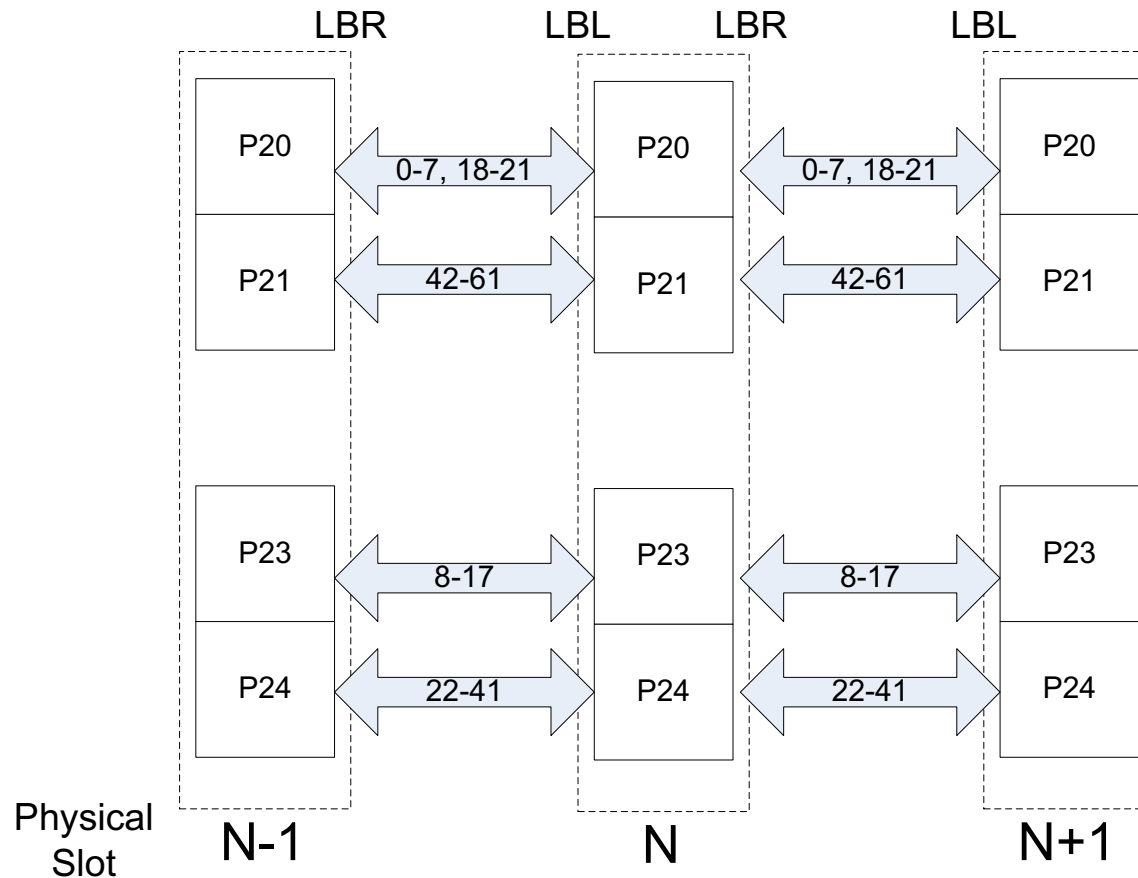
# AXIe-1 exploits unique bus topologies



# AXIe-1 adds Timing and Triggering to ATCA

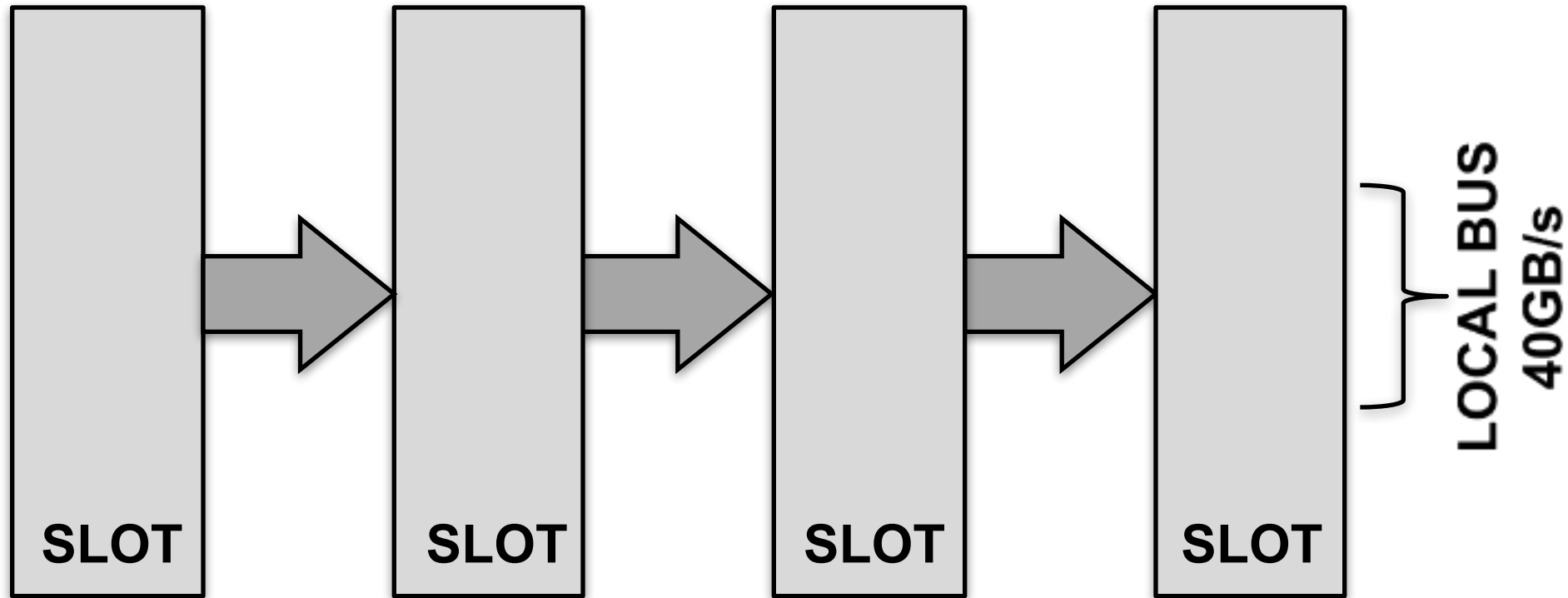


# AXIe-1 adds a High-Speed Local Bus to ATCA

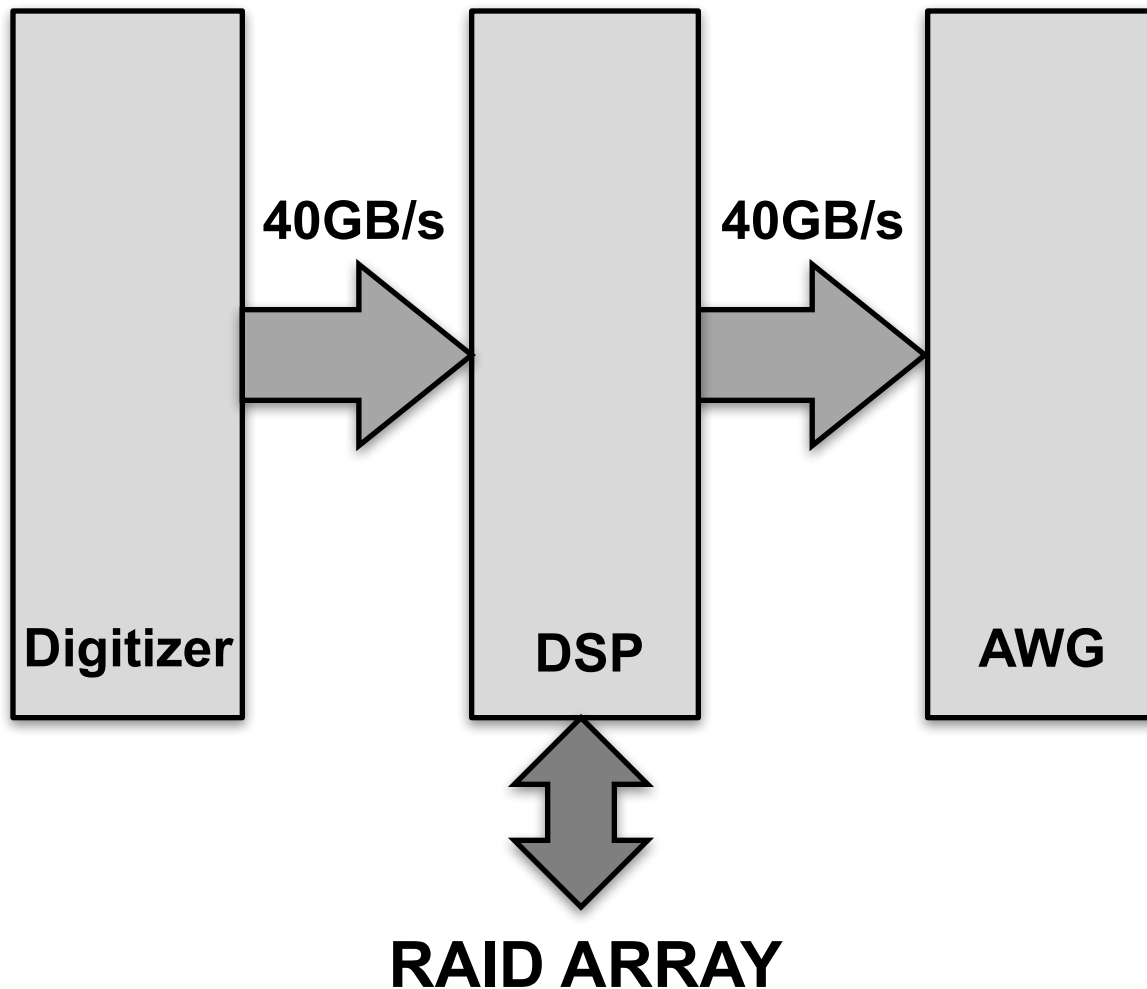


***Proven performance at 40GB/s  
using today's technology***

Local bus enables simultaneous high speed streaming between modules



Local bus enables very fast streaming between digitizers, DSP, and waveform generators

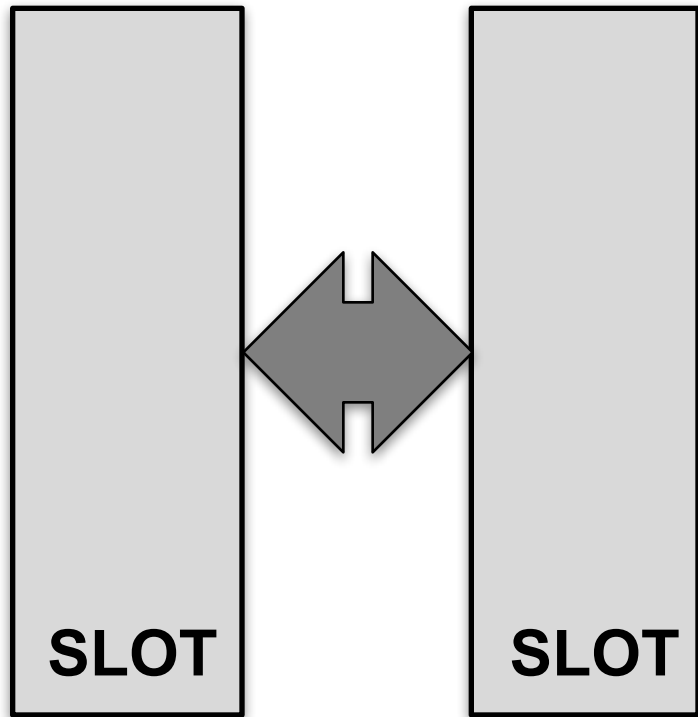


- 40GB/s today, more in future
- External RAID for nearly indefinite streaming
- Nearly endless number of configurations



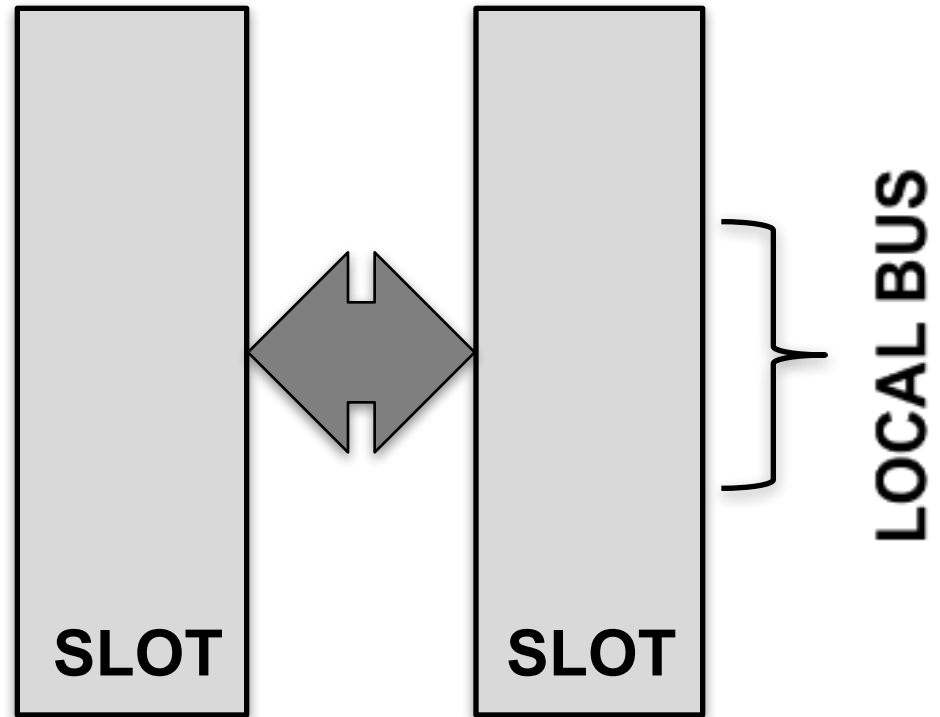
A vendor may use the local bus for any purpose, and it may span as many contiguous slots as the vendor wishes.

### High intimacy A



High isolation

### High intimacy B



Since local bus only communicates between adjacent modules, different vendors may use local bus differently, simultaneously.

# AXIe Speeds

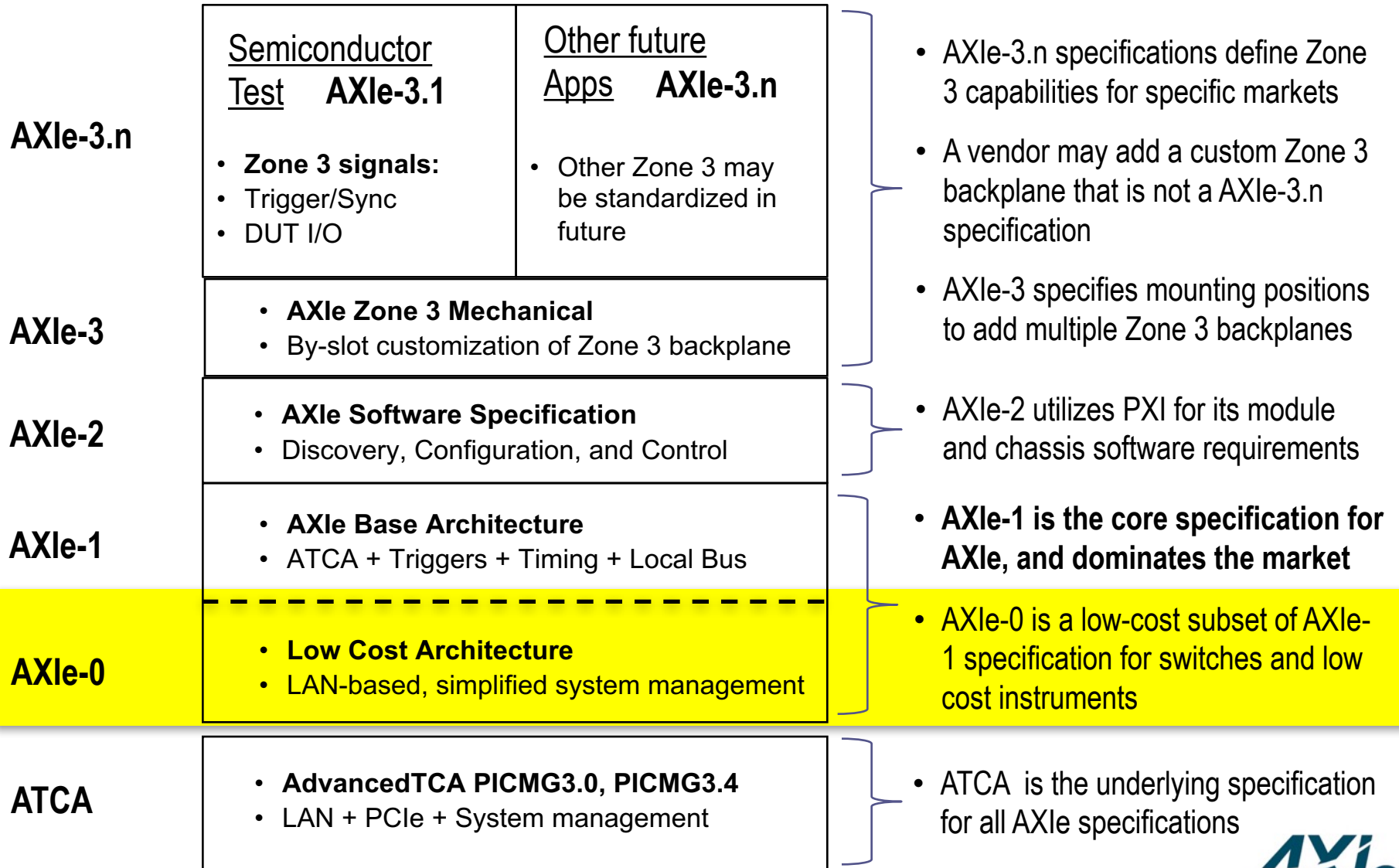
	Bus Speed (GB/sec)		
	PXIe: (PCIe x8)	AXIe: (PCIe x16)	AXIe Local Bus
PCIe Gen2	4	8	80 (demonstrated)
PCIe Gen3	8	16	

The chart above shows the maximum data rate of each architecture for a given transceiver speed. Bus speed is proportional to the number of lanes. Real world PCIe speeds are typically 20% lower than shown.

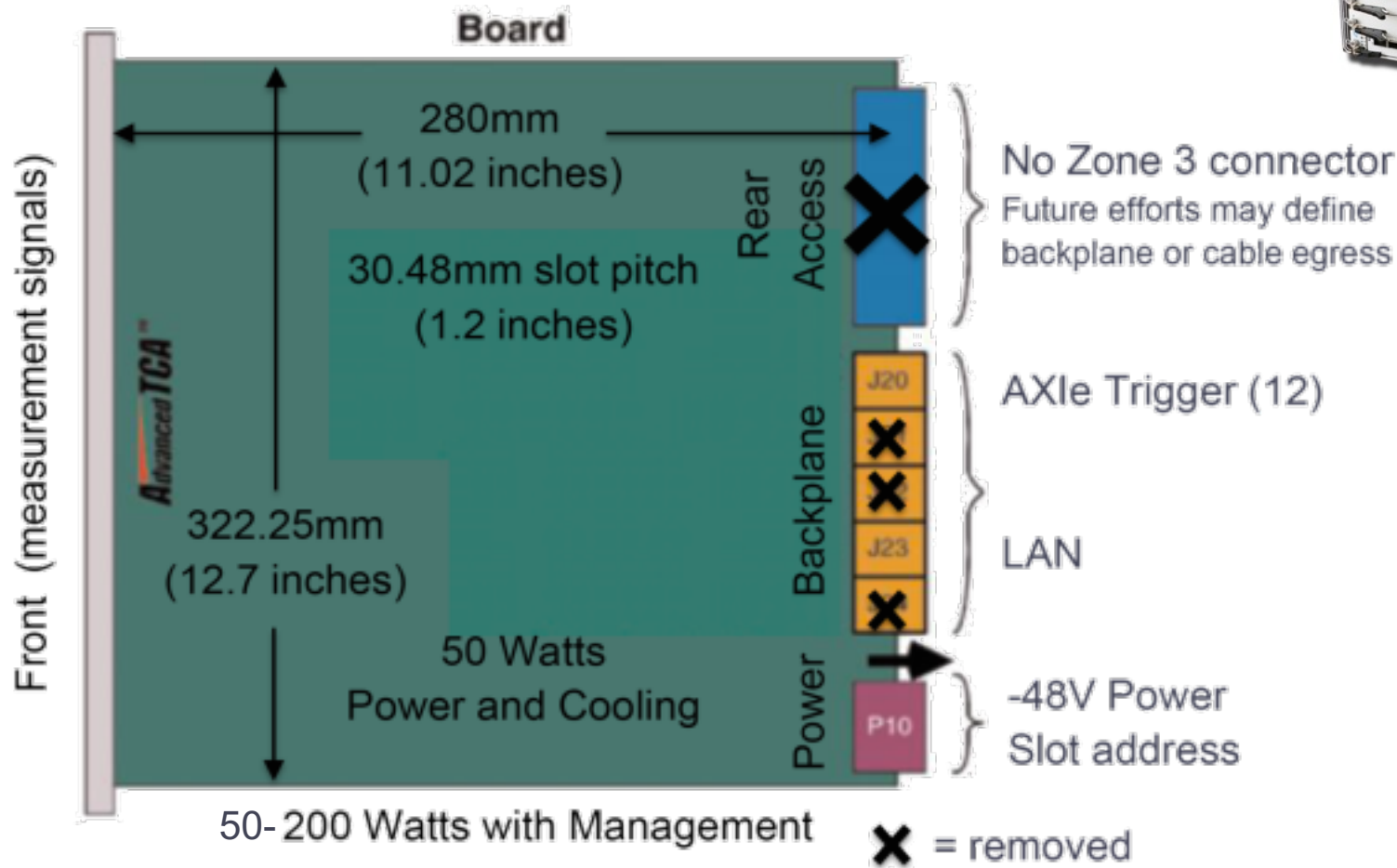
The AXIe Local Bus travels shorter distances, one slot pitch, and is not necessarily tied to PCIe or any other standard. Due to this, very high rates, up to 80 GBytes/sec, have been demonstrated.

[http://axistandard.org/files/AXIe\\_local\\_bus\\_speed\\_achieves\\_record\\_80\\_GB\\_.pdf](http://axistandard.org/files/AXIe_local_bus_speed_achieves_record_80_GB_.pdf)

# AXIe Specification Structure



# AXIe-0 LAN-only, same format



# AXIe-0 Applications

- Large switching systems and RF Interface Units
  - Mil/aero, electronic functional test
- Custom instrumentation from system integrators or users
  - Large board area and simple development
- VXI replacement in mil/aero
  - Replace large switching networks with AXIe-0
  - Incorporate management for modules >50 watts
  - Integrate PXI where needed using carriers
- General purpose and data acquisition
  - Architecture applicable to many instrument types
  - IEEE-1588 may be deployed when needed.

# AXIe Specification Structure

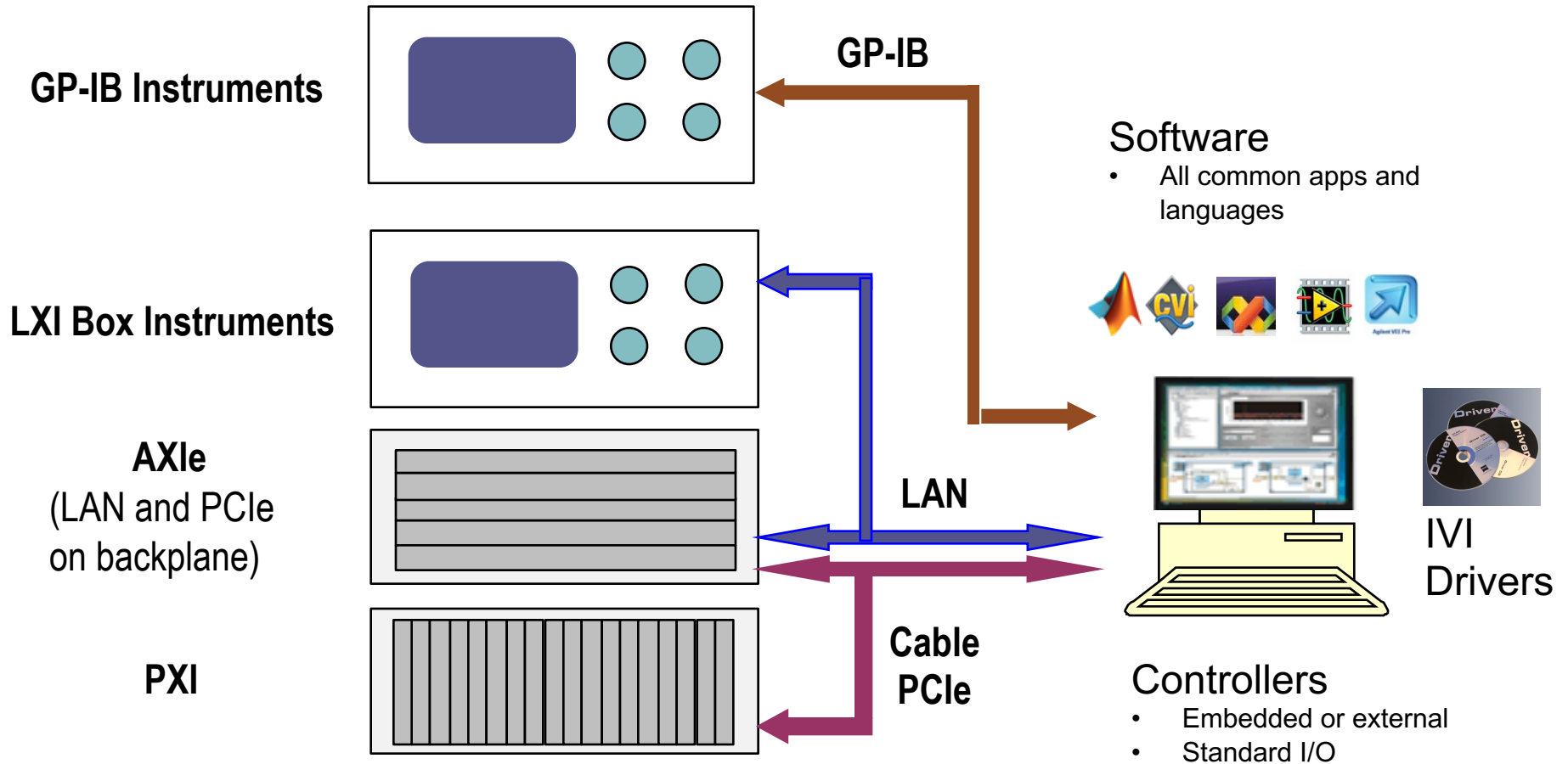
AXIe-3.n	<div><div><u>Semiconductor Test</u> <b>AXIe-3.1</b><ul style="list-style-type: none"><li>• <b>Zone 3 signals:</b></li><li>• Trigger/Sync</li><li>• DUT I/O</li></ul></div><div><u>Other future Apps</u> <b>AXIe-3.n</b><ul style="list-style-type: none"><li>• Other Zone 3 may be standardized in future</li></ul></div></div>	<div><ul style="list-style-type: none"><li>• AXIe-3.n specifications define Zone 3 capabilities for specific markets</li><li>• A vendor may add a custom Zone 3 backplane that is not a AXIe-3.n specification</li></ul></div>
AXIe-3	<div><ul style="list-style-type: none"><li>• <b>AXIe Zone 3 Mechanical</b></li><li>• By-slot customization of Zone 3 backplane</li></ul></div>	
AXIe-2	<div><ul style="list-style-type: none"><li>• <b>AXIe Software Specification</b></li><li>• Discovery, Configuration, and Control</li></ul></div>	<div><ul style="list-style-type: none"><li>• AXIe-2 utilizes PXI for its module and chassis software requirements</li></ul></div>
AXIe-1	<div><ul style="list-style-type: none"><li>• <b>AXIe Base Architecture</b></li><li>• ATCA + Triggers + Timing + Local Bus</li></ul></div>	<div><ul style="list-style-type: none"><li>• <b>AXIe-1 is the core specification for AXIe, and dominates the market</b></li><li>• AXIe-0 is a low-cost subset of AXIe-1 specification for switches and low cost instruments</li></ul></div>
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# AXIe-2: Base Software Specification

- Requires compliance with PXI-6
  - PXI Express Software Specification
- Almost no need for exceptions
  - AXIe always reports a single trigger bus
  - AXIe reports up to 4 links each with up to 16 lanes of PCIe Gen3
  - AXIe system driver generates Compact PCI EPROM data instead of reading from chassis
- Enables identical AXIe and PXI software
  - Same kernel driver and IO Library (VISA) naturally supports both PXI and AXIe

# AXIe integration with Rack and Stack



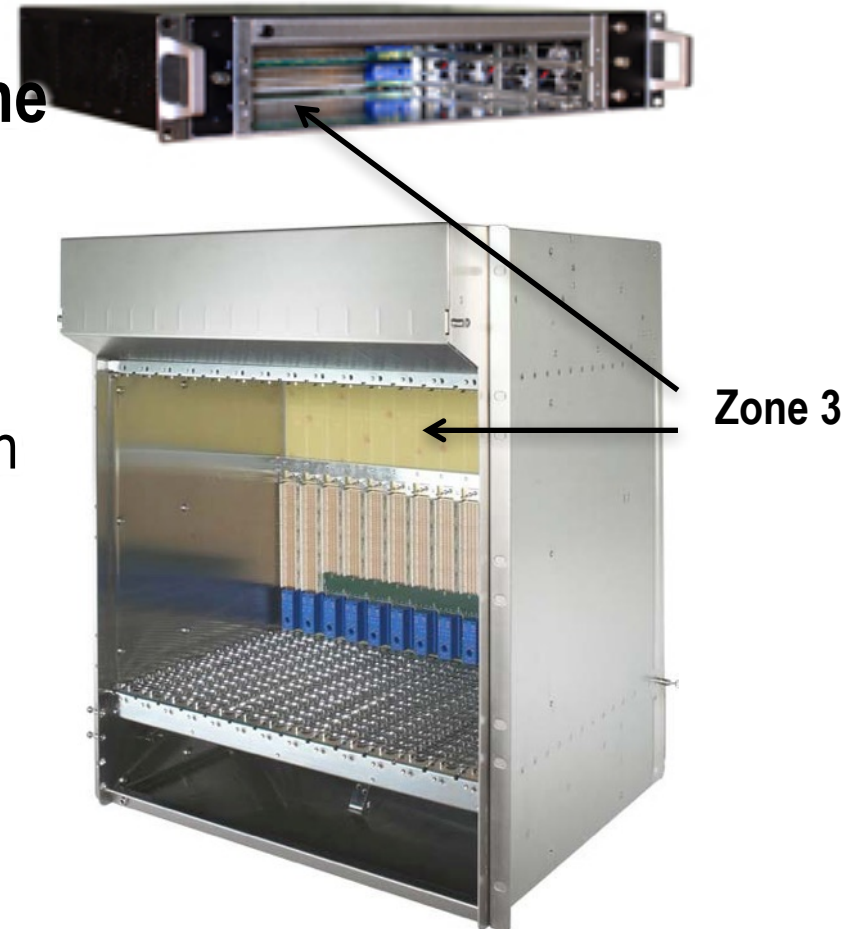
**Note:** Graphic for example only, instruments do not need to be co-located in same rack unit.

# AXIe Specification Structure

AXIe-3.n	<div> <div>Semiconductor Test AXIe-3.1</div> <ul style="list-style-type: none"> <li>• <b>Zone 3 signals:</b></li> <li>• Trigger/Sync</li> <li>• DUT I/O</li> </ul> </div> <div> <div>Other future Apps AXIe-3.n</div> <ul style="list-style-type: none"> <li>• Other Zone 3 may be standardized in future</li> </ul> </div>	<ul style="list-style-type: none"> <li>• AXIe-3.n specifications define Zone 3 capabilities for specific markets</li> <li>• A vendor may add a custom Zone 3 backplane that is not a AXIe-3.n specification</li> </ul>
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# AXIe-3 “Segmented Backplane”

- Enables multiple, different Zone 3 backplanes to be mounted into a chassis
  - Mechanical mounting specification
  - Custom or standardized Zone 3
  - Applications:
    - Signal ingress/egress
    - Precision timing
    - Analog bus
- Chassis are allowed to ship with a Zone 3 backplane already installed.



# AXIe Specification Structure

<b>AXIe-3.n</b>	<u>Semiconductor Test</u> <b>AXIe-3.1</b> <ul style="list-style-type: none"> <li>• <b>Zone 3 signals:</b></li> <li>• Trigger/Sync</li> <li>• DUT I/O</li> </ul>	<u>Other future Apps</u> <b>AXIe-3.n</b> <ul style="list-style-type: none"> <li>• Other Zone 3 may be standardized in future</li> </ul>	<ul style="list-style-type: none"> <li>• AXIe-3.n specifications define Zone 3 capabilities for specific markets</li> <li>• A vendor may add a custom Zone 3 backplane that is not a AXIe-3.n specification</li> </ul>
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# AXIe-3.1 Overview

## Zone 3 Semiconductor Test Extension

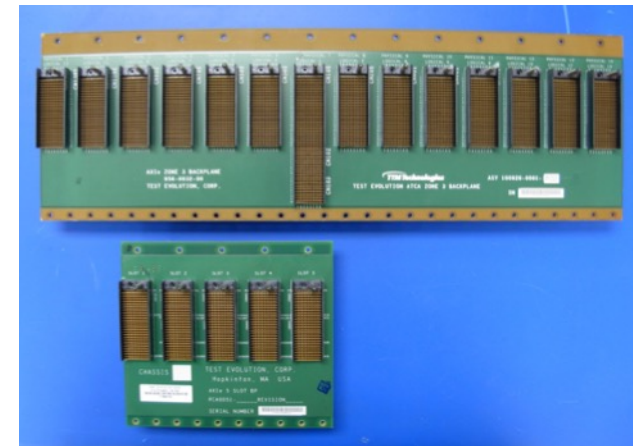
- Focused on semiconductor test
- Allows all signals to enter and exit through the rear via a single mass interconnect
- Provides for enhanced timing
- Provides for in situ diagnostics and calibration





# AXIe-3.1 Extensions

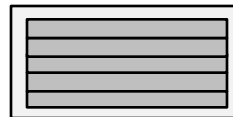
- Timing and Triggering Extension
  - Quad Bi-Directional Star Trigger to Each Slot
  - Digital Channel Vender-Defined Synchronization
- Test Fixture Support
  - Instrument I/O via Rear Transition Modules
- Field Calibration Path
  - External NIST traceable instruments
  - 4 Wire Kelvin Calibration Bus to each slot
  - 1 Amp, 300 Volt Max



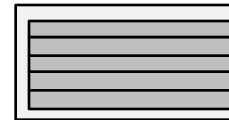
Example Zone 3 backplanes

# AXIe modules are upward compatible

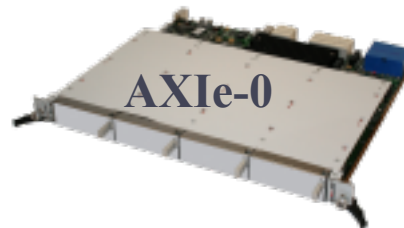
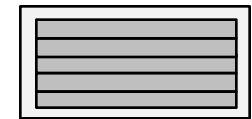
AXIe-0  
Chassis



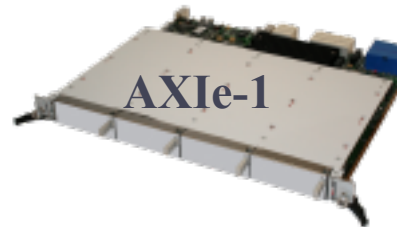
AXIe-1  
Chassis



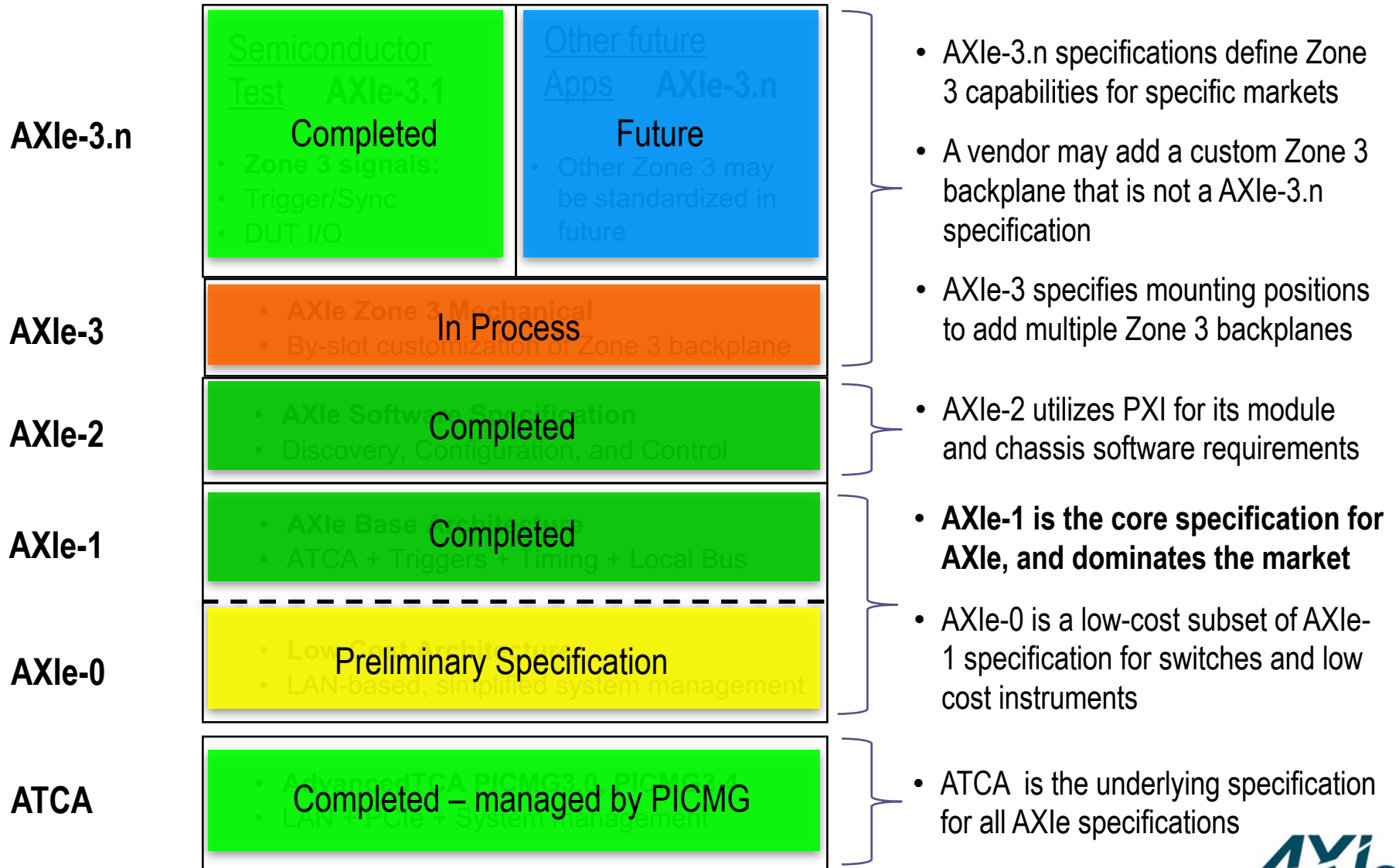
AXIe-3.n Chassis



- AXIe-0 modules work with AXIe-0, AXIe-1, and AXIe-3.1 chassis
- AXIe-1 modules work with AXIe-1 and AXIe-3.n chassis
- AXIe-3.n modules work only in AXIe 3.n chassis



# AXIe Specification Structure - Status



# AXIe is the “Big Brother” of PXI

Feature	AXIe	PXIe
Chassis base	AdvancedTCA	cPCI/cPCIe
PCIe maximum data bandwidth (Maximum Gen 3.0): Single peripheral slot to backplane All peripheral slots to system slot	2-16* GB/s 26-224* GB/s	4 GB/s 8 GB/s
PCIe fabric	Yes	Yes
LAN backplane	Yes	No
Local bus	62 differential pairs	1 line (13 PXI)
Triggers	Bidirectional Star Trigger 12 signal MLVDS bus	Star Trigger(1xTTL, 3x Diff per slot) 8 Signal TTL bus
Frequency Reference & Sync	100MHz, yes	10MHz, 100MHz, yes
Power per slot	200 W	30 W
Board space per slot (higher density, flexibility)	900 cm <sup>2</sup>	160 cm <sup>2</sup>
Modules available	>20	~1100

\* Gen3 x16 15.74GB/s top theoretical



# Summary

AXIe is the “big brother to PXI”:

- An open system modular instrumentation standard based on AdvancedTCA<sup>®</sup>
- that delivers high performance instrumentation
- for wireless comms, aerospace defense, high energy physics, semiconductor test, and other industries.

AXIe delivers:

- Industry’s fastest modular digitizers, AWGs, and digital products
- Superior power, circuit, and rack density
- Compatibility with LXI, PXI, and VXI

Specifications may be downloaded from the AXIe Consortium website at [www.axiestandard.org](http://www.axiestandard.org)