Embedded Tech Trends

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Instrument Architectures Go Serial

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History

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It is hard to say when the open architecture movement really started but with the release of the 8bit Intel 8008 processor in 1971 made it inevitable.

With the release of the VMEbus Rev. A specification in 1981 the open architecture revolution was clearly in full swing.

The concept of modular instruments was already present when Pomona boxes and oscilloscopes with plug-in modules became common.

However, the concept of a fully modular instrumentation system based on an open computer architecture became a reality with the release of the VXIbus in 1987.

Why Modular Instruments

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High school and college laboratories need instruments as do corporate skunk works, development labs and repair depots.

However, it is clearly the manufacturing production line that makes modular instruments a necessity.

Whether you are manufacturing radar systems, car tires, candy bars, cigarettes or consumer electronics there are processes that must automated. It is a basic principle that to control any process you must be able to measure it.

As production lines are re-configured for improved or new products, instrumentation must be re-configured as well. Modular test stations comprised of many different instrument modules make this possible.

Typical Modules

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Multi-meters
Signal Generators
Precision DC Sources
Counters, Timers
Digitizers
Oscilloscopes
Signal Analysis

Data Acquisition
Digital IO
Analog to Digital
Digital to Analog
Motion Controllers
Vision Systems

When high resolution camera signals needed to be processed the parallel busses were overwhelmed

Data acquisition systems also require higher speed data busses.

Modular Instrument Architectures

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Architecture	Form Factor	Organization	Date
VXI	Eurocard	VXI Bus Consortium - IEEE	6/1987
PCI	Desktop CEM	PCI-SIG (not instr. Specific)	4/1993
PXI™	Eurocard	PXI Systems Alliance	8/1997
PXI Express™	Eurocard	PXI Systems Alliance	9/2005
LXI™	Cable	LXI Consortium	9/2005
VXI-4 (VXS P0/J0)	Eurocard	VXS Bus Consortium	9/2009
AXIe™	AdvancedTCA™	AXIe Consortium	4/2011
PXI Express™(Gen3)	Eurocard	PXI Systems Alliance	T.B.D.

Parallel Architectures

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Architecture	Primary Data Plane	Secondary Data Plane	Data Rates
VXI	64bit parallel	Various serial	320 Mbytes/s
PCI (66 MHz)	64bit parallel		532 Mbytes/s
PXI™ (33 MHz)	32bit parallel	Various serial	133 Mbytes/s

Serial Architectures

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Architecture	Primary Data Plane	Secondary Data Plane	Data Rates
PXI Express™	1, 4, 8 or 16 lane serial	Various serial	4 x 5 GTs
LXI™	Serial cable	N/A	1 Gbps
VXI-4 (VXS P0/J0)	64bit parallel	x4 Serial with dual Ethernet	320 MBs/ 10Gb/s/ 1Gbs
AXIe™	X4 serial	Dual Ethernet	10 Gbps/ 1Gbps
PXI Express™ (Gen3)	1, 4, 8 or 16 lane serial	Various serial	4 x 8 GTs

Features of Instrument Busses

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	PXI Express™	VXI-4	AXIe™
Super Members	ADLink, Aeroflex, Agilent, Gigatronics, National Instruments, Pickering, Teradyne	Agilent, Bustec, EADS, National Instruments, Teradyne, VTI Instruments, ZTEC	ADLINK, Agilent, Modular Methods, Giga-tronics
Total Members	**55**	**15**	**7**
Base spec	CompactPCI™ Express™	VME™ + VXS™	AdvancedTCI™
Added to base Computer Spec/Standard	PXI_CLK10,PXIe_CLK100,PXIe_SYNC100,PXI_STAR,PXIe_DSTARA/B/C,PXI_STAR, SMBus, PXILBR, pxisys.ini, chassis.ini	Clocks, Triggers ECL, TTL, Local Bus, SYNC, StarX, StarY, Sync Trigger, Analog Sum bus, ModID, Ethernet, x4 Serial	FCLK, CLK100, SYNC, TRIG11, StarTrigger, LocalBus, (*Zone3*)
Module size	3U-160, 6U-160 x.8”	6U-160, 6U-340, 9U-340 x1.2”	322 -280 x 1.2”
Connectors	2mmHM, 3pair ADF	5-row IEC 61076-4-113 + MultiGig	4pairADF

Simulation Effort

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Architecture	Chair	Simulation Contributors
PXI Express **cPCI Express**	National Instruments (both efforts)	National paid for ERNI simulation (6 months)
LXI	N/A	N/A
VXI-4 (VXS P0/J0)	EADS/ DY-4	Tyco
AXIe **aTCA**	Agilent/ Motorola	Robert Cutler, Tyco, ERNI
PXI Express (Gen3) **CompactPCI Express**	National Instruments (both efforts)	National Instruments performed the simulations (2 years)
AXIe (40G) **aTCA – PICMG 3.1r2**	TBD Emerson	Simclar, Harting, Emerson, Pentair, Tyco, Elma (4 years)

Serial Upgrades

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The story behind the transition from parallel to serial bus architectures in the instrumentation busses is the story of the technical effort performed by the underlying bus architectures.

AXIe Channels

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Channel Type	*Channel Size*	*Pairs/Port*	*Maximum Ports/Channel*	*Channels/Slot*
Base	4 pairs	4 pairs	1 Port	1-14 Channels
Fabric	8 pairs	2 pairs	4 Port	2-13 Channels
Local Bus	18 pairs	18 pairs	1 Port	0-2 Channels
	42 pairs	42 pairs	1 Port	0-2 Channels
	62 pairs	62 pairs	1 Port	0-2 Channels
Timing	1 pair	1 pair	1 Port	4 Channels

Serial Upgrades

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High speed serial channels allow more data to be moved from acquisition to analytical engines and back to the instrument, operator or storage to enable real-time dynamic systems.

A stamping press producing a two up real of precision electrical contacts at a rate of 20 contacts per second may have as many as 28 progressive forming stations in one stamping die.

Optical inspections with multiple cameras can image and measure and analyze as many 20 features and the results can be used to stop a line as soon as it goes out of tolerance or dynamically control the press to bring the parts back into tolerance.

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Thank You

Acroynms

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IVI™ –Interchangeable Virtual Instruments
LXI™ –LAN eXtensions for Instrumentation
PXI™ –PCI eXtensions for Instrumentation
PXIe™ –PCI Express eXtensions for Instrumentation
VXI-1 –VME eXtensions for Instrumentations
VXI-4 –VME eXtensions for Instrumentations with VXS serial