PICMG® – 25 YEARS OF OPEN SPECIFICATIONS FOR EMBEDDED COMPUTING

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Open Modular Computing Standards

PICMG* [PCI INDUSTRIAL COMPUTER MANUFACTURER'S GROUP]

Open Modular Computing Standards

Founded 1994 as a non-profit consortium

- Focus on open standards for embedded computing
- ~ 150 members companies

Deep engineering expertise in member companies:

- Electronic, mechanical, packaging, and thermal design
- High speed signaling and simulation
- Software and High Availability skills

Rigorous Intellectual Property policies

- Patent landscape known to implementers
- No PICMG standard requires a license to implement (so far)

Over 50 standards released to date

- More than $10B in global revenue
- Wide range of technologies including small form factor, networking, high-availability architectures, rugged computing and management

*Pronounced "Pick-M-G" or "Pick-Mig"

OVERVIEW: 25 YEARS OF SPECIFICATIONS

Open Modular Computing Standards

Key Principles

- Modular
- Scalable
- Interoperable

Results to date

- 100s of participating companies
- 100s of thousands of work hours
- Global organization
- Over 50 specifications
- Billions of dollars in PICMG compliant products

Collaboration will always be critical to PICMG

µTCA® CompactPCI® Serial CompactPCI® SHB Express™ COM Express® AdvancedTCA®

VALUE OF OPEN STANDARDS

PICMG Open Modular Computing Standards

Proprietary Solution

- Typically developed, built, and maintained by a single vendor – Little or no collaboration
- Generally expensive and rarely the latest technology
- Only the largest companies have all of the requisite skills to be experts on all elements
- Upgrades developed on vendor's timetable – the vendor "owns" you

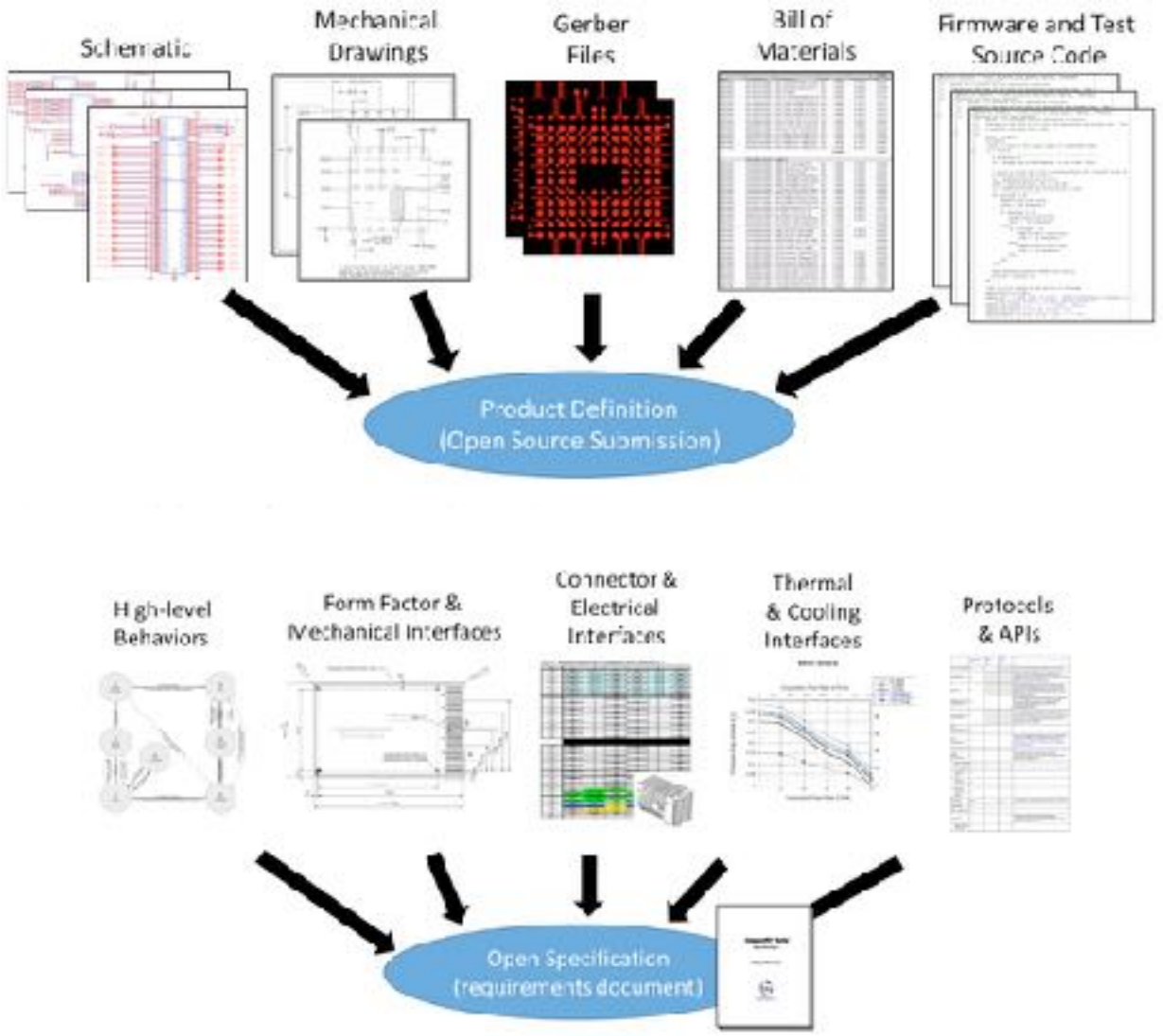
Open Standard Solution

- Generally developed by non-profit consortia with many members that have a wide range of skills
- Multiple vendors provide price and feature competition
- If customers don't like their vendor(s) they can go someplace else
- Technology and improvements developed on industry timetable

Open Standards encourage innovation and differentiation amongst multiple vendors – interoperability is key

OPEN SPECIFICATION VS. OPEN SOURCE

Open Modular Computing Standards



PICMG TIMELINE

Open Modular Computing Standards

Spec Family	1994 1995	1996 1997	1998 1998	2000 2001	2002 2003	2004 2005	2006 2007	2008 2009	2010 2011	2012 2013	2014 2015	2016 2017	2018 2019
PICMG 1.0	Moved all of the components normally located on a PC motherboard to a single plug-in card or SBC (SHB added PCI Express slots)												
SHB Express	1.0					1.3 r1	1.3 r2						
CompactPCI	CompactPCI 3U & 6U Euro card , PMC specifications family												
	2.0		2.3	2.16						EXP.0			
AdvancedTCA	Advanced Telecommunications Computing Architecture												
					3.0			3.3			3.7	3.1 r3	
MicroTCA	Modular, open specifications for building high performance switched fabric computer systems in a small form factor												
							MTCA.0	MTCA.1	MTCA.3/4	MTCA. 2			MTCA.0 Rev.2
AdvancedMC	Family of mezzanine card specifications for AdvancedTCA and MicroTCA												
						AMC.3	AMC.2	AMC.4					AMC.2 Rev.2
HPM	Hardware Platform Management specifications augment management layer of three key PICMG platforms: AdvancedTCA, AMC and MTCA												
							HPM.0				HPM.2	HPM.3	
CompactPCI Serial	High speed serial interconnects while maintaining CompactPCI mechanical specifications and backwards compatibility with older I/O cards												
									CPCI-S r1		CPCI-S r2	cPCI Serial Space	
COM Express	Computer On Module (COM) single board computers family of specifications												
						COM.0 r1			COM.0 r2			COM.0 r3	

MARKETS SERVED

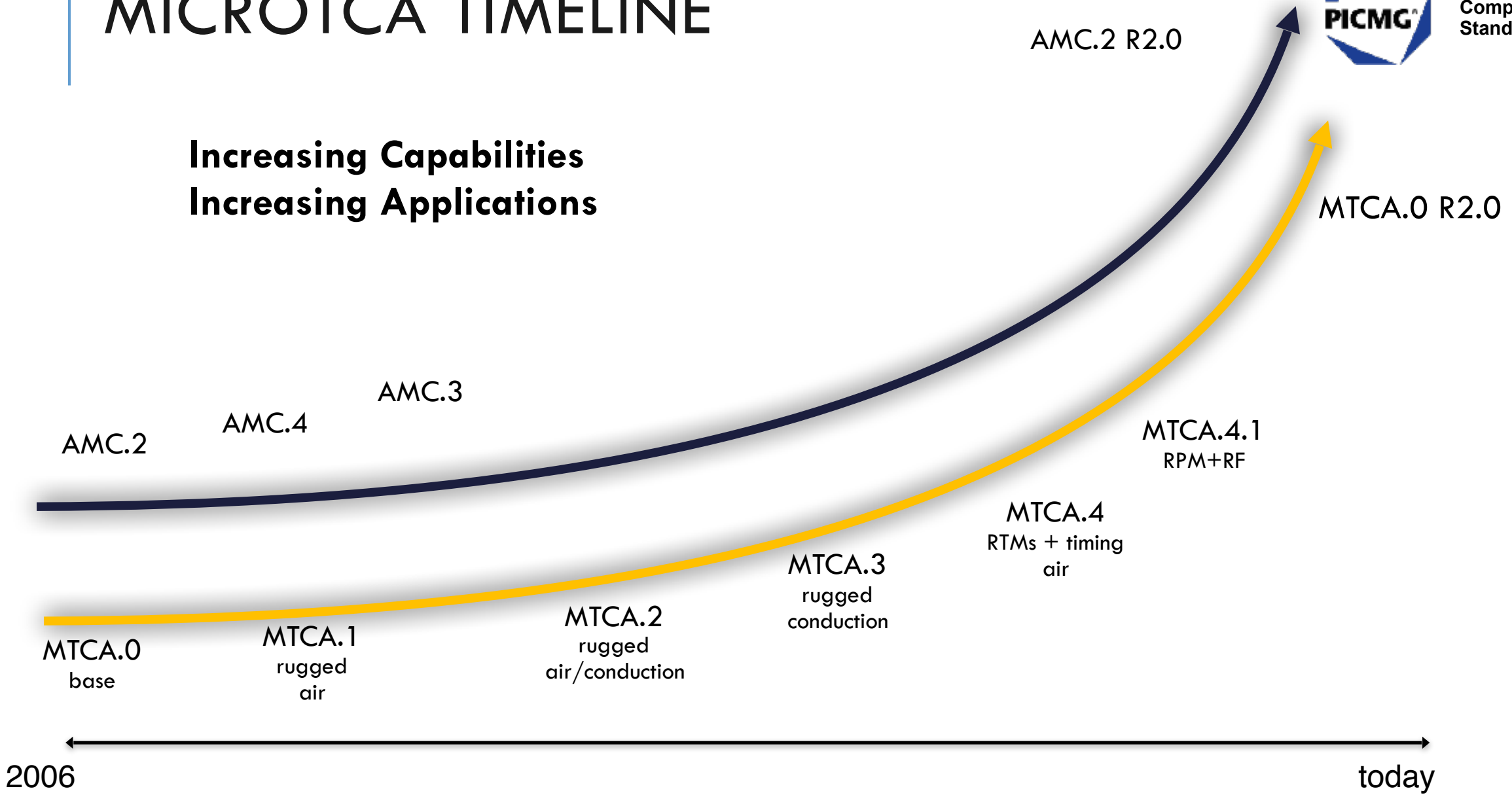
Open Modular Computing Standards

	COM Express	CompactPCI	CompactPCI Serial	HPM	MicroTCA / AMC	AdvancedTCA	SHB
Aerospace	X	X	X	X	X		
Defense	X	X	X	X	X	X	X
Drones / UAV	X	X	X	X	X		
Energy	X	X	X	X	X		X
Gaming	X						
Industrial Automation	X	X	X		X		X
IIoT	X	X	X				
Medical	X	X	X	X	X		
Physics				X	X	X	X
Railway	X	X	X	X	X		
Telecommu-nications	X			X	X	X	
Test / Measurement	X	X	X	X	X	X	

MICROTCA TIMELINE

Open Modular Computing Standards

Increasing Capabilities
Increasing Applications



Q3/Q4 SPECIFICATION UPDATES

Open Modular Computing Standards

AMC.2 Revision 2.0

- Implementation of 1, 10 and 40 Gbps Ethernet (PICMG® 3.1 1000BASEBX and PICMG® 3.1 10GBASE-BX4 subset of IEEE 802.3 XAUI signaling, respectively) links on AMC.0 Modules and Carrier Boards.

MTCA.0 R2.0

- This revision of the specification update provides several corrections to Rev 1.0 of the MicroTCA® Specification
- Defines a path to higher speed Ethernet fabrics including 10GBASE-KR and 40GBASE-KR4.

MEMBERS WHO CONTRIBUTED TO MICROTCA 4.0/4.1

Open Modular Computing Standards

ADLINK Technology Inc.
Analog Devices, Inc.
Arroyo Technology Consultants
CERN
Communication Automation Corp.
DESY
Elma Electronic Inc.
IN2P3-CNRS
Institute of High Energy Physics
Intel Corporation
Kontron
Micro-Research Finland Oy
mm3consulting
N.A.T. GmbH
National Instruments
nVent, Schroff GmbH
Pixus Technologies Inc.
powerBridge Computer Vertriebs GmbH
SLAC National Accelerator Laboratory
TE Connectivity
TEWS Technologies
Triple Ring Technologies, Inc.
W-IE-NE-R Power Electronics GmbH
Yamaichi Electronics

RESOURCES

Open Modular Computing Standards

General

- www.picmg.org
- Design Guides
- Shortform specifications
- Product Showcase
- Active MicroTCA marketing group
  - Updating forms, web content, Wikipedia
- Specifications available for purchase on the website (We prefer you join, participate and receive the specs via membership)

Design Guides and more on the PICMG Web site:

Physics Design Guide for Clocks, Gates & Triggers in Instrumentation

Standard process models and APIs

Standard device models and APIs

PICMG® MTCA.4 PCI Express Hot Plug Design Guide

Standard Hardware API Design Guide

Always interested in application stories, blogs and other contributed materials

SPECIFICATION DEVELOPMENT

Open Modular Computing Standards

Process

- 3 exec members sponsor a new initiative
- Develop initial statement of work
- CTO Review
- Call for participation
- Committee formed
- Chairperson, Editor and Secretary elections
- Committee finalizes SOW
- Specification work begins
  - Regular calls with role and IPR acknowledgements
- Draft specification reviewed by CTO
- Member review
- Necessary updates made by committee
- Ratification vote

BENEFITS OF MEMBERSHIP

Open Modular Computing Standards

Early access to key technology

Participate in specification development

Leverage PICMG promotions and marketing efforts

Develop relationships with thought leaders and suppliers

Gain visibility and leads from your products and content on the PICMG Web site

Low-cost membership – Affiliates join for as low as $1000.00*

ADDITIONAL 2019 INITIATIVES

Open Modular Computing Standards

Active

- COM-HPC
  - Support for PCIe Gen 5.0 (32 Gb/s)
  - 64 PCIe Lanes
  - Min. 25 Gb Ethernet per signal pair to support 100 Gb Ethernet
  - Update of other interfaces

COM-HPC will not replace COM Express. It extends the Server-On-Module ideas.

- Rugged COM Express
- IIoT
  - Sensor data model
  - H/W interface form factor
- University outreach

Always Rumblings…

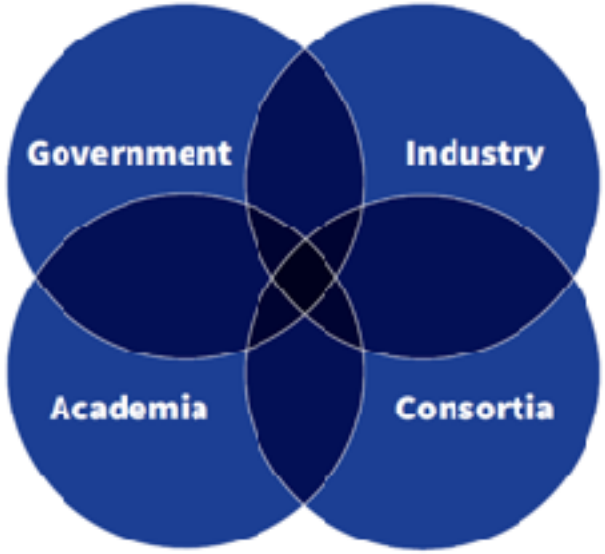
- Next generation
  - CompactPCI Serial
  - MicroTCA (beyond 40G)

Member driven!

FUTURE

Open Modular Computing Standards

- Continued support for MicroTCA
- Greater support for DESY MicroTCA Technology Lab
- Value of Open Standards / Specifications vs. proprietary solutions remain the same
- Continued Globalization of requirements
- More diverse engineering force
- Greater collaboration



SAMPLE OF MEMBERSHIP (~150 TOTAL)

PICMG
Open Modular Computing Standards

DESY.

vadatech
THE POWER OF VISION

ess EUROPEAN SPALLATION SOURCE

nVent SCHROFF

BAE SYSTEMS

AIRBUS

SLAC NATIONAL ACCELERATOR LABORATORY

IOxOS TECHNOLOGIES
RELIABILITY BY DESIGN

X-ES
Extreme Engineering Solutions

ADVANTECH
Enabling an Intelligent Planet

EKF SYSTEM

intel

kontron

ELMA
Your Solution Partner

NATIONAL INSTRUMENTS

EUROTECH

THANK YOU

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AXIOMTEK CO., LTD.
BAE Systems
BeeBeans Technologies
Beijing LinkedHope Intelligent Technologies
Bielefeld University
BittWare, Inc.
CERN
Communication Automation Corp.
Comtel Electronics
Concurrent Technologies PLC
Conference ConCepts, congatec AG
Connect Tech Inc.
Data Modul AG
DESY
DFI Inc.
Dolphin Interconnect Solutions
Dynetics, Inc.
Ebrains, Inc.
Ecrin Systems
EKF Elektronik GmbH
Elma Electronic Inc.
Embeck Co.
EmbedWay Technologies Corporation
Emerson Machine Automation Solutions
ENGICAM
Engineering Design Team ept GmbH
esd electronics gmbh
European Spallation Source ERIC
Eurotech S.p.A.
Extreme Engineering Solutions
FASTWEL Group Co. Ltd.
Forschungszentrum Julich GmbH
Galleon Embedded Computing
GDCA
General Micro Systems I
GOMA ELETTRONICA
Hartmann Electronic
HEITEC AG
Hewlett-Packard Enterprise
IOxOS Technologies
KEK
KEL Corporation
Keysight Technologies
Kongsberg Defence and Aerospace
Kontron
Honeywell, Inc.
IBASE Technology Inc.
IN2P3-CNRS
Institute of High Energy Physics
Intel Corporation
Lodz University of Technology
Luminator Technology
Marvin Test Solutions
Meidensha Corporation
Meinberg Funkuhren GmbH & Co. KG
MEN Mikro Elektronik
Micro-Research Finland
Mitsubishi Electric TOKKI Systems Corporation
mm3consulting
MSC Technologies
Nexcom International
Nokia Solutions and Networks
North Atlantic Industries
Northrop Grumman Systems Corp.
N.A.T.
National Instruments
NetApp
New H3C Group
nVent, Schroff
Oak Ridge National Laboratory
OpenSystems Media
PAVO Tasarim Üretim Elektronik Tic. A.S.
Pixus Technologies
Polyrack Electronic-Aufbausysteme GmbH
Portwell, Inc.
Positronic Industries
powerBridge Computer Vertriebs
Prodrive Technologies
PSMA
Qualcomm
Raytheon Company
Really Big Company
REJ Co., Ltd.
RIKEN SPring-8 Center
RTD Embedded Technologies, Inc.
Samtec
Sanritz Automation Co., Ltd.
SECO SpA
Simonson Technology Services
SLAC National Accelerator Laboratory
Southco Inc.
SRC Corporation
STAR-Dundee
STFC
Taiwan Commate Computer Inc.
TE Connectivity
Telesoft Technologies
Tews Technologies GmbH
TQ-Systems GmbH
Trenz Electronic GmbH
Triple Ring Technologies
VadaTech
Vectology,
VersaLogic C
W-IE-NE-R Power Electronics
Yamaichi Electronics

MOSA APPROACH

Open Modular Computing Standards

Modular Open System Approach (MOSA) to computer architecture design. MOSA benefits include:

- Systems that are adaptable to evolving requirements
- Improved interoperability
- Enhanced commonality and reuse of components among systems
- Shorter development time
- Enhanced supportability and reduced life cycle costs
- Technology transparency for rapid upgrades

UNIVERSITY MEMBERSHIP LEVEL

Open Modular Computing Standards

- Kicked off 2018
- University of Lodz
- Bielefeld University

Academic Member benefits

- Must comply with bylaws
- Must sign and comply with IPR
- 15 .pdf specs per year (more available for additional fee)
- Ability to participate in sub committees
- No voting rights (must become an exec member for voting rights)
- Publication / Promotional opportunities
- Contribute blog posts
- Publish articles
- Website listing with link
- FEE: $1500 / year