Summary of 2nd ATCA/MicroTCA Workshop for Physics Applications

LCWS 2008 University of Illinois
Rev: November 18, 2008
Originally presented at 2008 IEEE NSS-MIC
Dresden Oct 23, 2008

R.S. Larsen
SLAC National Accelerator Laboratory

Definitions

- xTCA
  - Family of open standard products including ATCA, AMC & MicroTCA
- ATCA
  - Advanced Telecom Computing Architecture, full sized card used alone or as a carrier for AMC modules
- AMC
  - Advanced Mezzanine Card, typically 3 or 4 per ATCA Carrier but up to 8 in theory; also packaged as MicroTCA
- ATCA Shelf
  - Telco-speak for standard Crate
- MicroTCA
  - Smaller shelf containing only standard AMC modules
- IPMI, HPM
  - Intelligent Platform Management Interface, Hardware Platform Management Software
  - Diagnostic and control subsystem underlying xTCA high availability features such as hot swap, power, environmental & maintenance management
- PICMG
  - PCI Industrial Computer Manufacturer's Group; consortium for standards

Workshop Program

Program was aimed at new users having basic familiarity with xTCA

Day 1: Invited Presentations

- Industry ATCA Standards Tutorials
- Physics Standards Requirements
- Industry Design Experience Talks

Day 2: Invited & Contributed Presentations

1. Invited Industry Tutorial Demonstrations
2. Contributed Papers Lab & Industry Applications
3. Discussion: Future Standards Collaboration

Standards Tutorials

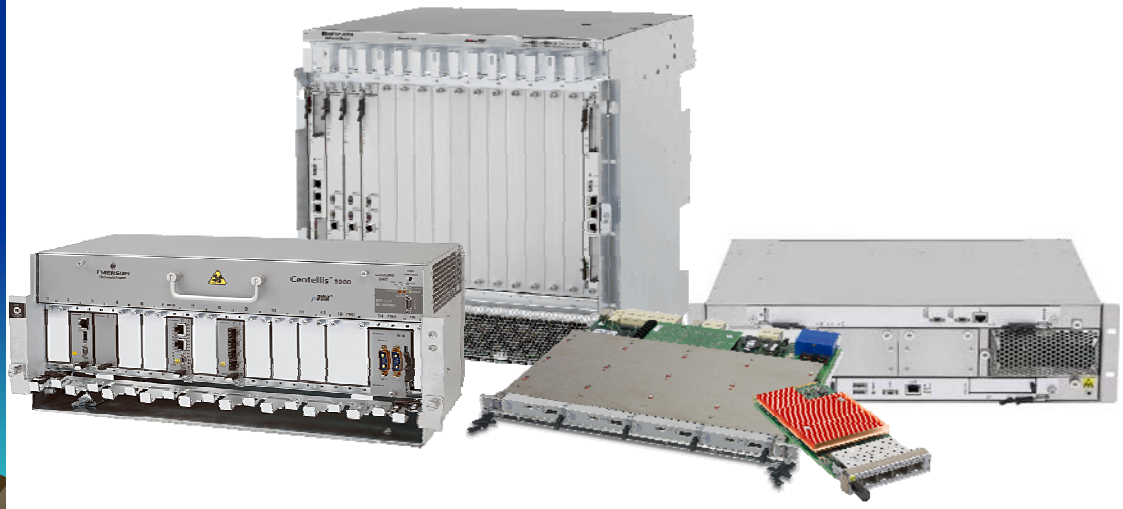
- Presentations by industry experts involved with ongoing standards development
  - *Hardware:* Chris Engels
    - Sr. Technical Marketing Manager, Embedded Computing, Emerson Network Power, Munich
  - *Software:* John Fryer
    - Director of Technology Marketing, Embedded Computing, Emerson Network Power, Marlborough MA
    - President OpenSAF[1] Foundation

[1] *Service Availability Forum*

Overview of ATCA, AMC and µTCA

2nd ATCA/µTCA for Physics Workshop
October 18-19 2008
2008 IEEE Nuclear Science Symposium, Dresden

Chris Engels
Emerson Network Power Embedded Computing



IPMI

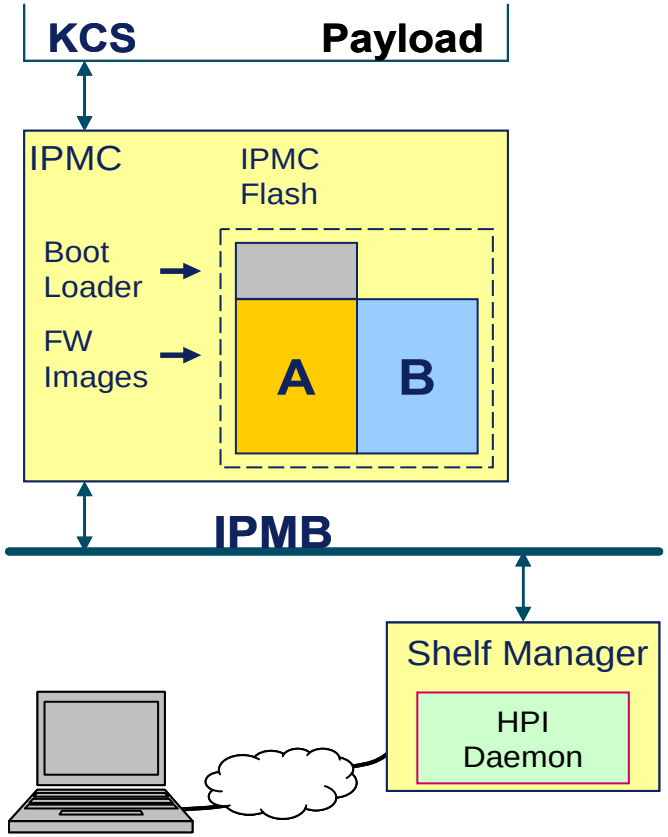
- Standard created by Dell, Intel, NEC
- Indented to remotely maintain and monitor server platforms
- Independent of OS or working payload
  - Reset, power cycling of payload
  - Force boot from specific devices
  - Watchdog to supervise payload
  - Serial over LAN (SOL) to access BIOS console
  - Sensor events (e.g. thermal monitoring, intrusion detect)
- IPMI can run on different protocols (e.g. IPMB, LAN, KCS)
- IPMI 1.0, 1.5, 2.0 Specifications
- PICMG references IPMI 1.5 – products may also comply to IPMI 2.0 (e.g. because of SOL)
- Has been adopted by PICMG for its purpose
- Extension in PICMG where necessary (e.g. setting face plate LEDs)
- Support for tools by open source community (e.g. ipmitool)

MicroTCA New Developments

- MicroTCA now released for 2 years
- Interest from a wide-range of Markets including
  - Industrial, Transportation, MIL/Aero, Outside Plant
- Common theme, extended Temp/Shock/Vib.
- Led to the Rugged MicroTCA SIG – hence to PICMG Rugged MicroTCA
- Conduction Cooled MicroTCA formed <March 08>
- MicroTCA Air-cooled split into two parts <Sep 08>
- Hybricon/Emerson among MicroTCA.x promoters
  - unveiled POC of Rugged and Conduction Cooled µTCA air transport rack

PICMG HPM.1

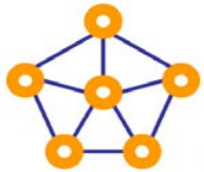
- "Hardware Platform Management IPM Controller Firmware Upgrade Specification"
- Describes a standardized method for remotely upgrading IPM Controller Firmware (FW)
  - PICMG 3.0 IPMC
  - AMC.0 carrier IPMC and MMC
  - MicroTCA.0 MCMC and EMMC
- Defines a protocol for remote firmware (FW) upgrade via IPMI
  - prepare IPMC for upgrade, transfer FW and activate it
- Common format for FW upgrade image
- Rollback, redundant FW images supported
- Via IPMB or other IPMC I/F if supported
- Supported by HPI via FUMI using ATCA mapping
- Enables FW upgrade of multi vendor FRUs in a single shelf using common FW upgrade tool



Hardware Standards Summary

- ATCA
  - Specification mature, applications growing successfully
  - IPMI, HPM.1 stable
  - Network speed increasing toward 10GbE base channel per IEEE emerging standards
  - Characterizing analog performance on interconnects
  - Initiative to standardize Zone 3 (user defined) failed
  - Higher power limits for air cooled cards “tolerated”
- AMC
  - Standard very stable; no new initiatives
- MicroTCA
  - High interest for non-Telco applications
  - Initiatives on rugged version, conduction cooling for military, process control industry
  - Rear IO under discussion
- Other Form Factors
  - New embedded shelf management & non-redundant low cost shelves for industrial controls applications appearing on market

SLAC NATIONAL ACCELERATOR LABORATORY



OpenSAF
The Open Service Availability Framework

SERVICE AVAILABILITY™ FORUM

Tutorial:
Overview of xTCA Software, Service Availability Forum (SA Forum) Framework
And
OpenSAF High Availability Middleware

John Fryer

Director of Technology Marketing, Emerson Network Power

President, OpenSAF Foundation

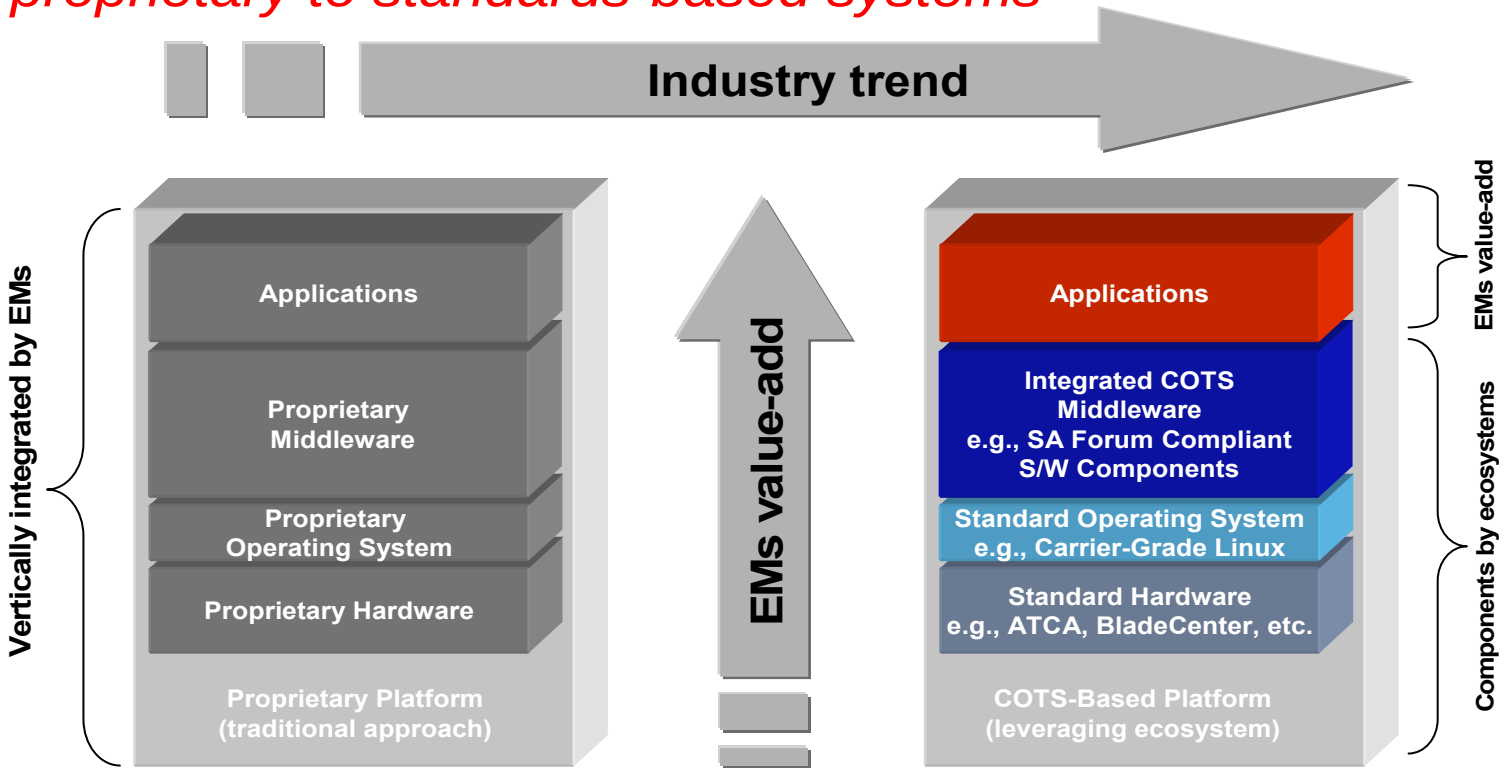
Member of the Board of Directors and Marketing Work Group Chair, Service Availability Forum

John.fryer@emerson.com

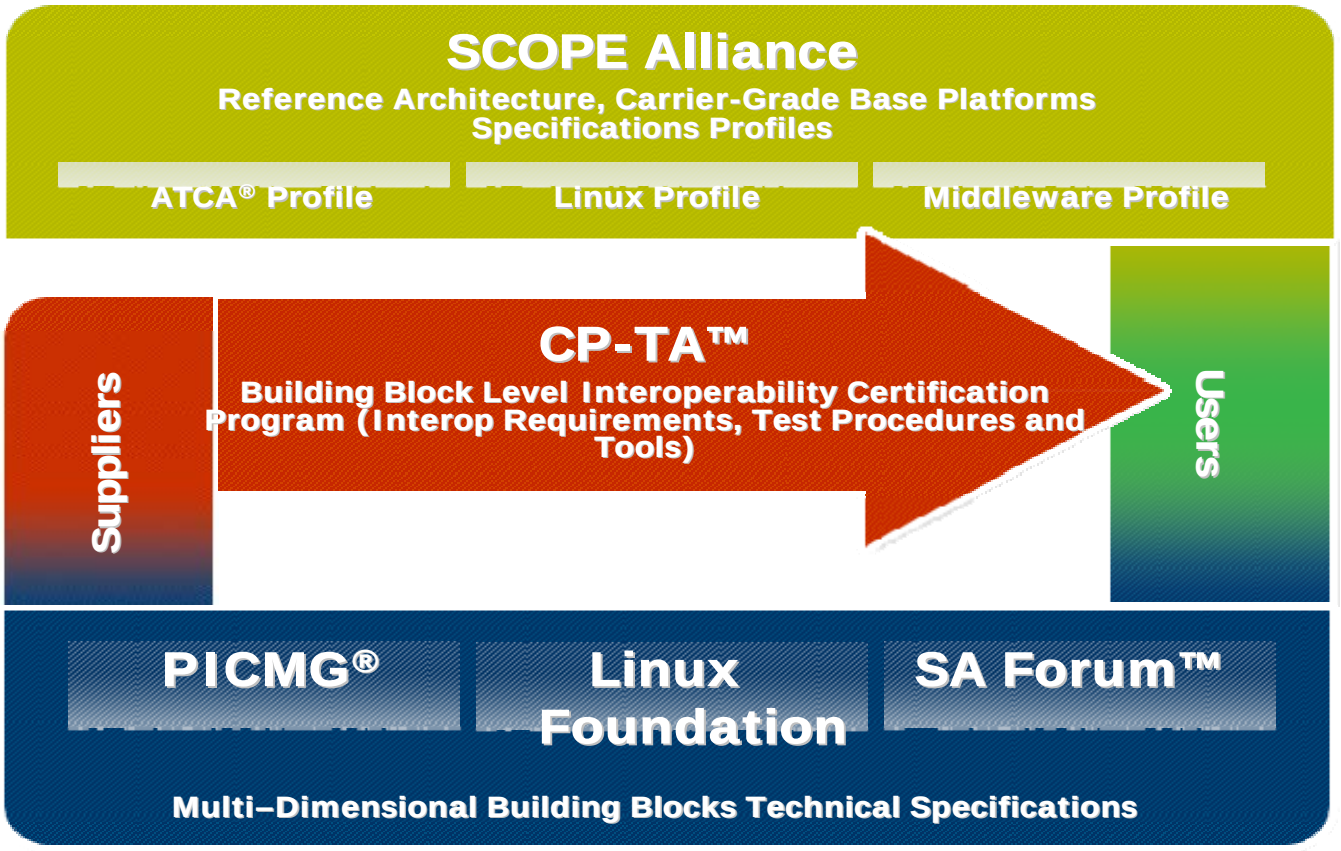
October 15, 2008

Role of Open Specifications

COTS adoption is accelerating transition from a vertical to horizontal industry model
AND key open specifications are catalyzing a move from proprietary to standards-based systems

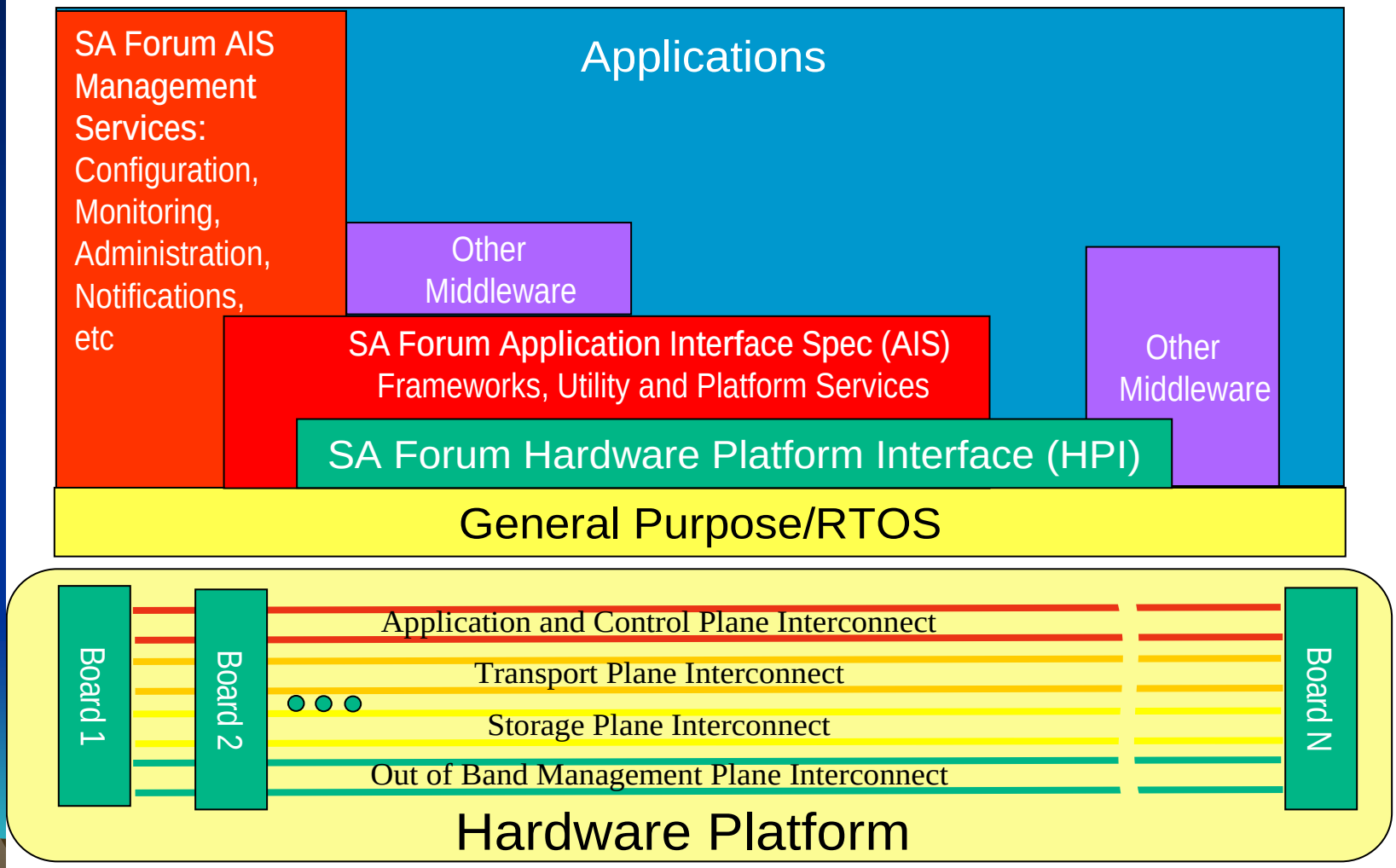


Special Interest Group (SIG) Eco-System Landscape



CP-TA - Communications Platforms Trade Association

Basic Architecture View



So Where Are We?

Specification Work

- *HPI: solid, mature specification*
- *AIS: relatively new, but solid set*

Implementation

- *HPI is a commercial success*
- *AIS compliant Middleware implementations are just emerging*
- *Some large EMs have internal implementation programs*

Industry Adoption

HPI is already a commercial success

Hardware Platform Providers

- Augmentix
- Continuous Computing
- Emerson ECC
- Hewlett Packard
- IBM
- Intel
- Kontron
- Performance Technologies
- Pigeon Point
- RadiSys
- Sun Microsystems
- And others

Middleware Providers

- ENEA
- GoAhead Software
- Others

Open Source Implementation

- OpenHPI

HPI Tester

- Polaris

SA Forum Members

Industry Adoption

AIS implementations available in the market

Pre-Integrated Platform Providers

- Continuous Computing
- Emerson Network Power-EC
- Fujitsu Siemens Computers
- Hewlett Packard
- IBM
- RadiSys
- Sun Microsystems
- Others

Middleware Providers

- ENEA
- GoAhead Software
- OpenClovis
- Emerson Network Power- EC

Open Source Implementations

- OpenAIS
- OpenClovis
- OpenSAF

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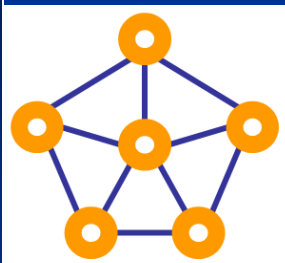


OpenSAF

The Open Service Availability Framework

Overview And Architecture

John Fryer
President,
OpenSAF Foundation
John.fryer@emerson.com

October 15, 2008

Rancore Technologies

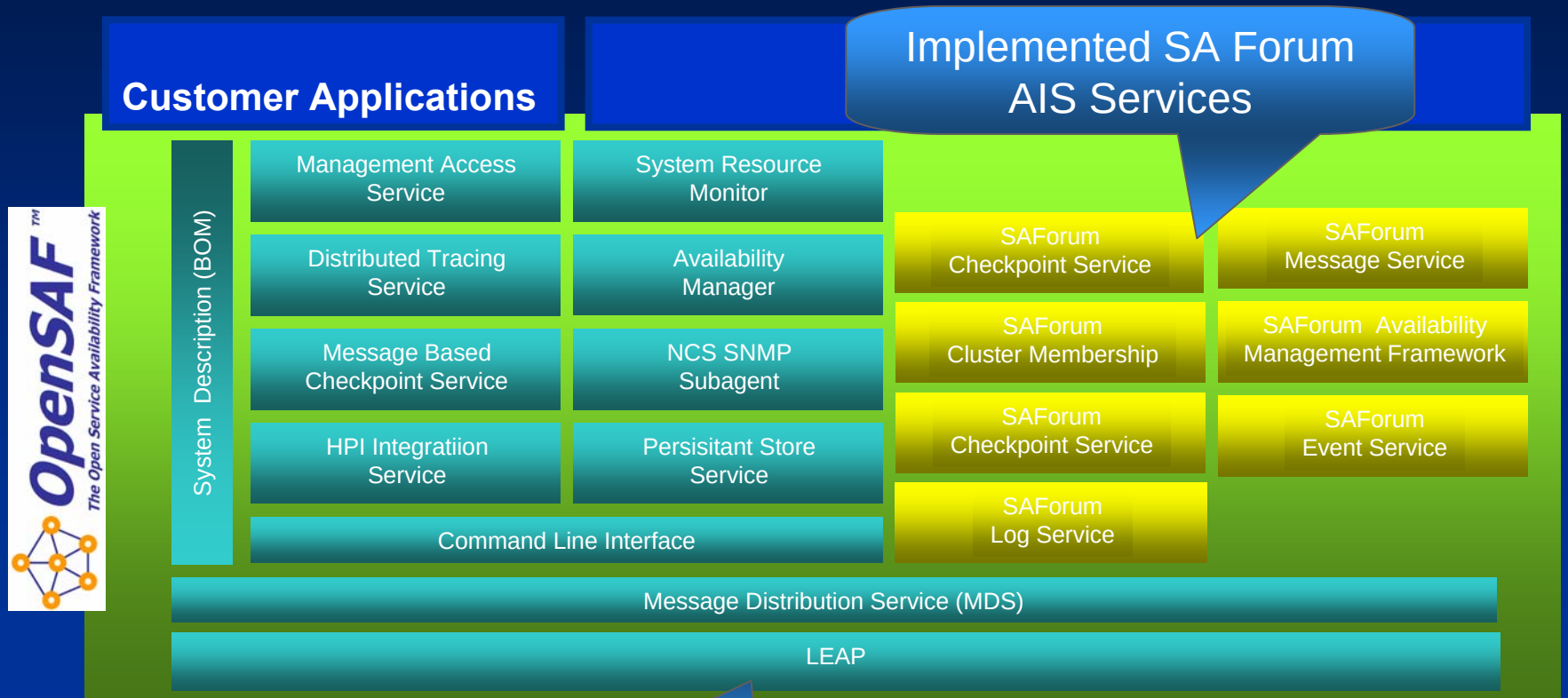
WIND RIVER

OpenSAF Goals

- **Accelerate the development of open specification base platform middleware**
  - **Aligned with SA Forum specifications**
  - **Guided by SCOPE Alliance recommendations**
- **Add capabilities necessary to deploy and manage the software**
- **Establish a broadly adopted base platform middleware**
  - **Initially focused on communications market – high availability**
  - **Extended to Enterprise computing, and other industries**

Leverage Collective Industry Expertise

Functional Elements of OpenSAF



Infrastructure services necessary for a High-Availability Operating Environment

Benefits of OpenSAF

- *Application Portability* – Adherence to Open SAForum Specifications provides you the freedom to move your applications around to other HA middleware implementations if you so choose.

- *Avoid Vendor Locking* – A closed commercial solution locks you to a particular vendor as current SAF specifications only account for 60 – 70 % of what a real HA Telco platform needs. Usage of the other services (that SAF doesn't offer) from a commercial vendor locks you in. With an open solution you have a voice and control on what you lock into.

- *Foster an Ecosystem* that enables ISVs and 3rd party vendors to pre-integrate their solutions with OpenSAF which enables you to pick off the shelf solution offerings from Database, Protocol stack and other 3rd party software vendors.

Software Standards Summary

- SAF Goals
  - Develop eco-system to support *high service availability* with standardized interface & management tools for COTS products
  - Develop & publish HA software interface specifications
- OpenSAF
  - Foundation of user companies to develop Application Interface management middleware
- Scope Alliance and CP-TA (Comm. Platforms Trade Assn)
  - Define profiles (specification subsets) to assure COTS product *interoperability* and provide *certification service*
  - *CP-TA promotes "Plug Fests" to test interoperability*
- Progress
  - Roadmap of SAF, Scope Alliance successful, critical to interoperability of COTS or custom products in HA systems
- *Participation in SAF & Scope Alliance open, highly beneficial to academic & research community users*

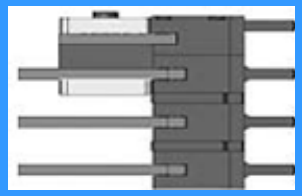
Physics Standards Requirements

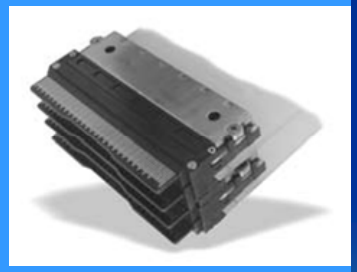
- Hardware – Robert Downing
  - xTCA platform has many advantages for physics
  - Propose developing down selection options into an xTCA Physics Profile
  - Follow SCOPE methodology, Gap Analysis
  - Candidate areas to narrow choices:
    - Protocols – Ethernet & PCIe
    - Rear IO for ATCA, AMC; designate AMC extra lanes for IO; possible options with stacking connectors
    - Recommend IO connectors – copper, fiber, high BW
    - Recommend board interconnect, routing design rules
    - Cooling options for crates, rear transition area (RTM), racks
    - Redundancy options to optimize to application
      - High BW, throughput for concentrated DAQ vs. low BW, long distance controls networks

Draft xTCA for Physics Profile

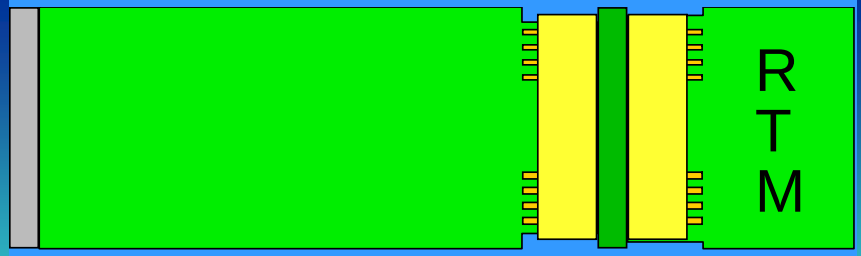
- Document is a combination of
  - SCOPE ATCA
  - SCOPE AMC
  - Gap Analysis
  - Our views of µTCA (work to be done)
  - Our edits
  - Example Issue: AMC RTM Connector Stacking Options

- Stacked (MCH) style connectors





- RTM attaches in rear in area where standard signals reside, two options:
  - Same connector, Extended Options to rear
  - Stack connector, all pins usable



Comment

- "Industry seems to be concentrating on narrowing xTCA specifications for compatibility – original spec offered too many options. Software "compatibility" is coming at a rapid rate.
- "Complexity of software on xTCA has forced cooperation to develop within a high availability hardware environment. Seems to be a first – normally one sees divergence in the market with time. Should result in higher volume and lower cost – good! "
  - *R.W. Downing*

Physics Standards Requirements

- Software – Claude Saunders
  - ATCA modeled for ILC Controls requirements
  - Applied AMF* to EPICS
  - Implemented successfully on Test Stand
  - Concluded AMF API simple to implement, plus brought many other services under AIS umbrella
- Proposed new EPICS PV Gateway ATCA implementation at Argonne Photon Source (APS)
- Listed issues for Physics Software Profile

* Availability Management Framework (part of SAF AIS)

ATCA Features of Interest, Organized by HA Concerns

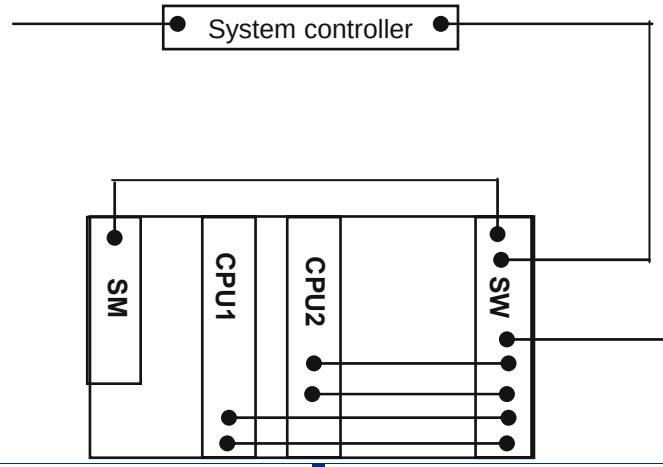
- Serviceability (MTTR)
  - ATCA (and related) brings:

- *Software Standardization*
  - Note: The software standards are not exclusive to ATCA systems, or Linux OS. They can be applied to any controls software and hardware platform.
- *Hardware resource monitoring and management*
  - SAF HPI (Hardware Platform Interface)
- *Software monitoring and management*
  - SAF AIS (Application Interface Specification)
- *Carrier Grade Linux (CGL)*

Software Features

OpenNMS
OpenIPMI tools
OpenHPI tools
OpenClovis tools

EPICS ATCA Test Stand



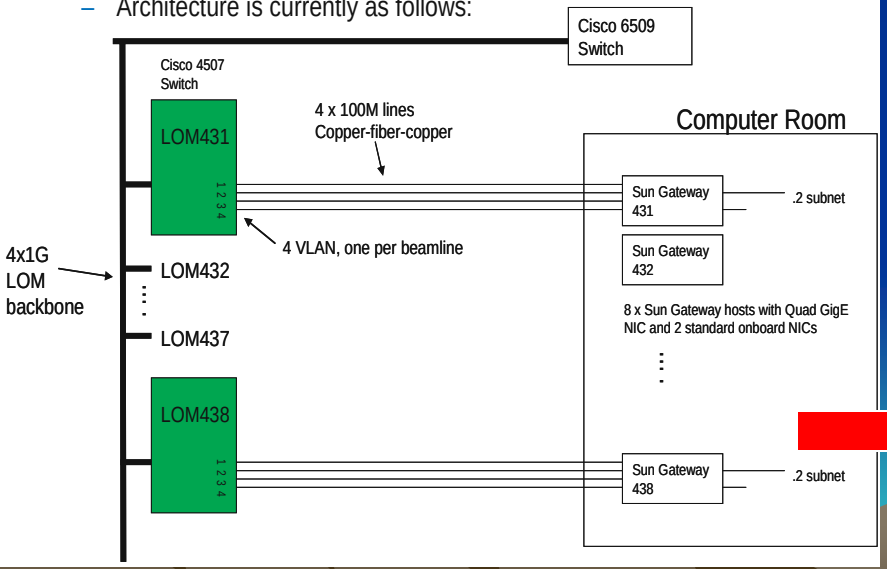
TIPC (non-INET protocol)
IPMI/SOL over RMCP (UDP)
SNMP (UDP)

Controls network

APS PV Gateway Proposal

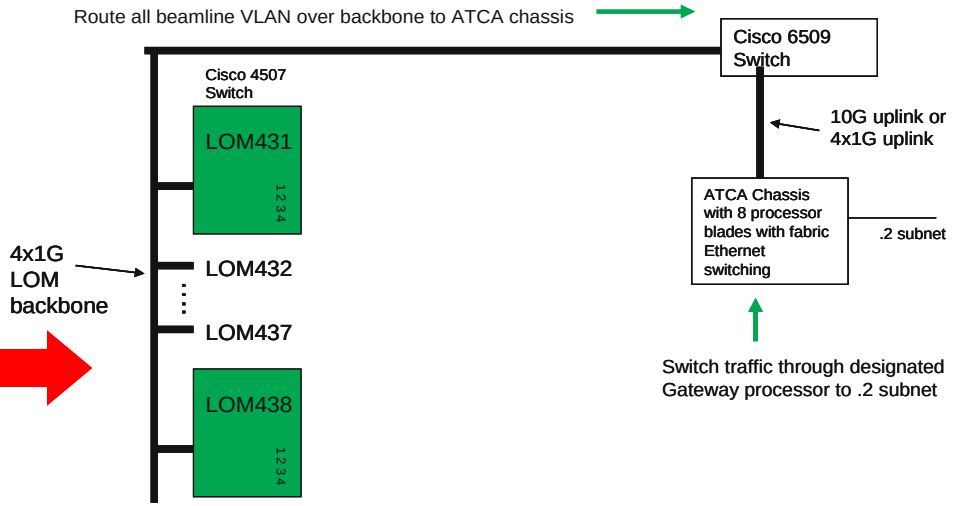
Proposal for HA EPICS PV Gateway

- Proposal at Advanced Photon Source to redesign deployment of EPICS process variable gateways
  - Architecture is currently as follows:



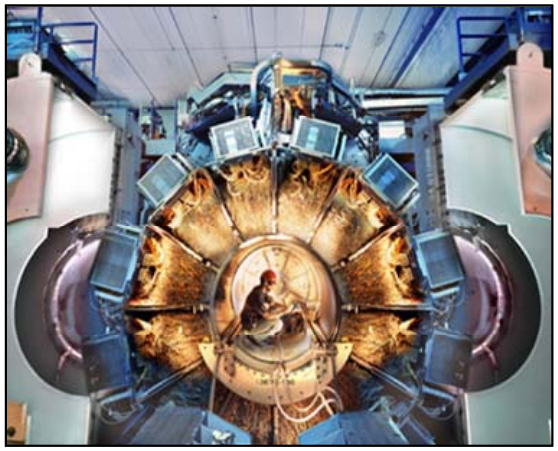
Proposal for HA EPICS PV Gateway

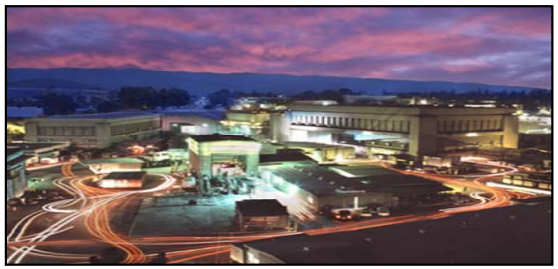
- Proposed architecture involving full ATCA shelf
- PV Gateway software to be managed with SAF AIS
- Hardware on ATCA chassis to be managed with SAF HPI



Software Profile Matrix

- Dimensions to Software Profile Matrix
  - ATCA versus uTCA platform
  - Control versus DAQ application
  - Simple (non-redundant) versus full High-Availability requirement
  - I/O Controller versus Data/Connection Concentrator application
- Which of the AIS sub-specifications are of interest to us?
  - RTOS versus CGL (or regular Linux)
  - Straight IPMI or HPI
  - Out-of-Band (OOB) Monitoring and Management
  - Control Plane (Base Interface) versus Data Plane (Fabric Interface)





2nd ATCA for Physics Workshop IEEE 2008 Nuclear Science Symposium

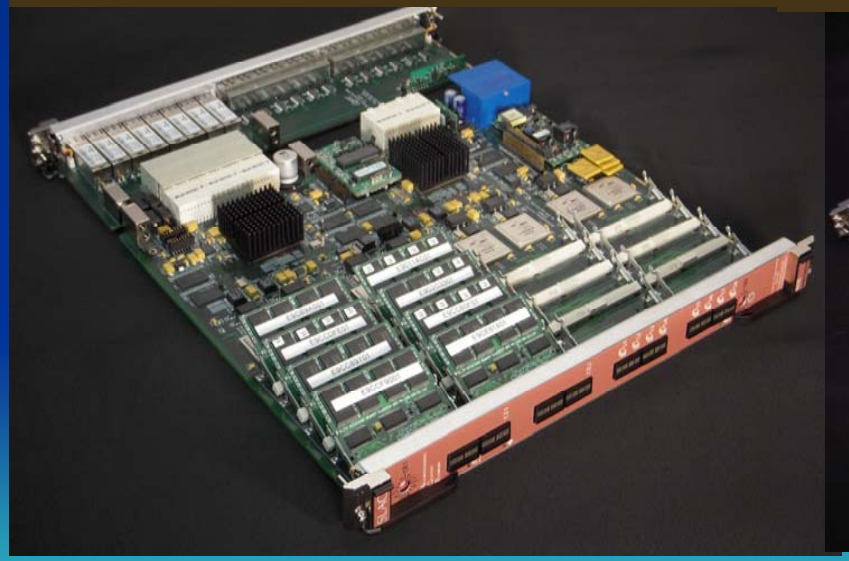
ATCA as a viable platform for future HEP DAQ systems

Michael Huffer, mehsys@slac.stanford.edu
Stanford Linear Accelerator Center
October, 18, 2008

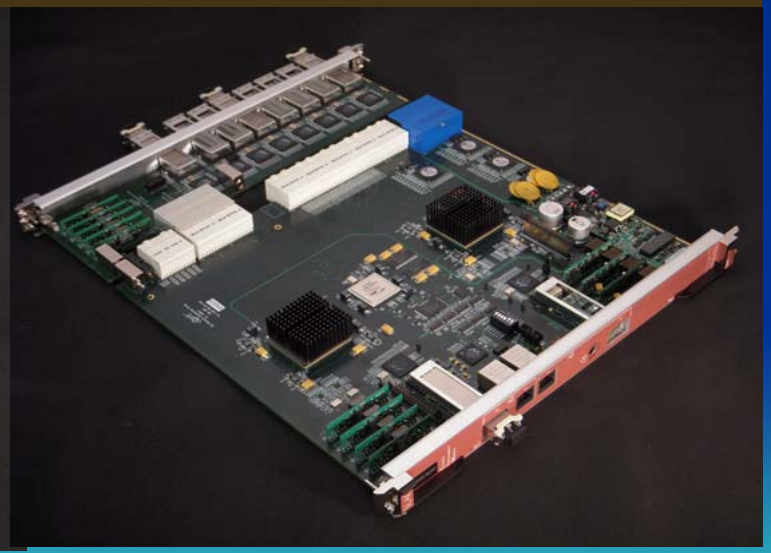
DAQ Elements

- Computational: Reconfigurable Cluster Element (RCE)
- Interconnection: Cluster Interconnect (CI)
- Standard Platform: ATCA
- Evaluation project underway at SLAC

RCE board + RTM



Cluster Interconnect board + RTM



Report Card for ATCA DAQ

- A+:
  - COTS solution, generous form factor, hot swap for HA, IPM monitoring & control, 1-voltage power system, RTM, serial backplane
- C-:
  - Doesn't like power draw from main board
  - BW of current backplane too low (Note-improvement to 10 Gbps/lane coming; may be limit for copper?)
- *Conclusion: ATCA architecture will serve as cornerstone for next generation DAQ*

Industry Presentations & Tutorial Demos

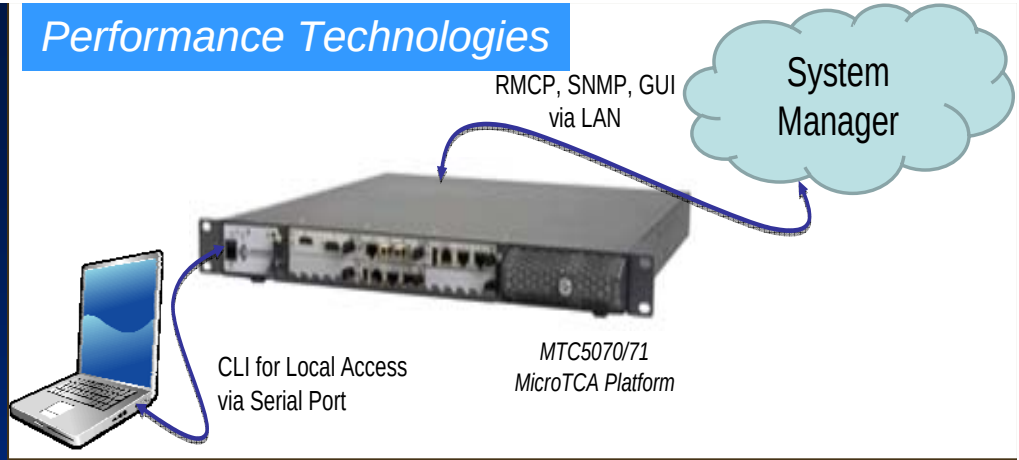
- TC3-1 AMC Design Experience
  U. Tews, TEWS Technology
- TC3-2 Simple MicroTCA for Industrial Control
  T. Holzapfel, powerBridge Computer
- TC3-3 Real-Time X-Ray Tomosynthesis Imaging Using an ATCA General Purpose Data Analysis Platform
  A. Lowell, Triple Ring Technologies
- TC3-4 Shelf Management for Optimized Cooling in ATCA Shelves
  D. Mann, Schroff
- TC5-1 xTCA Management and Maintenance - The Easy Way
  N. Forrester, Emerson Network Power
- TC5-2 Shelf Management Systems Interactive Demonstration
  T. Romero, Performance Technologies
- TC5-3 MicroTCA Interoperability
  C. Girgenrath, N. A. T.

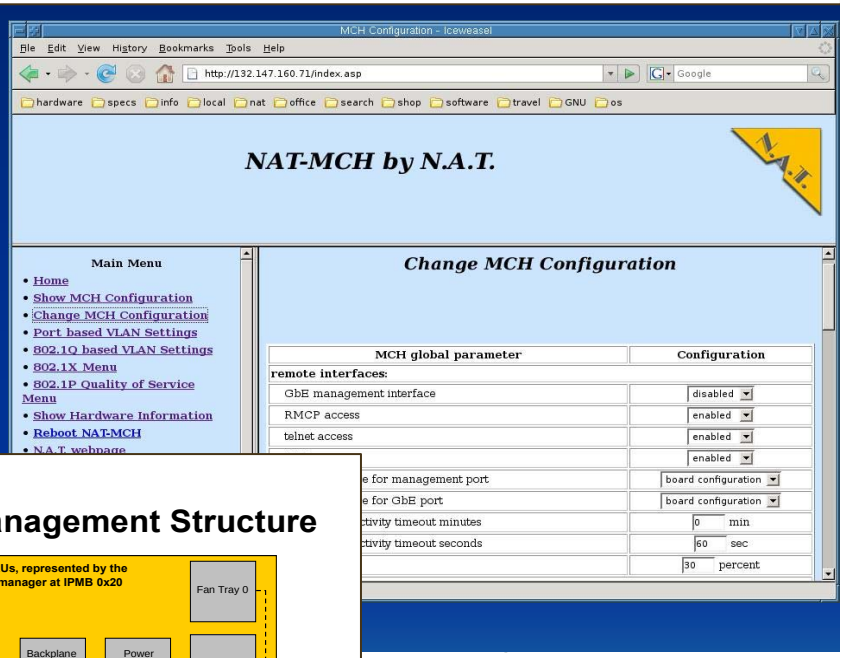
Industry Presentation Highlights

- Strong set of new AMC based products from Tews, powerBridge and Performance Technologies
  - Emphasize simplicity and lower costs for industry applications
  - Embedded platforms without full MicroTCA features (too expensive if not justified)
  - AMC adapters for Industry Pack (IP), PMC standards
  - 105 Ms/s 14 bit ADC from TEWS
  - Integrated systems with IPMI managers from PT, powerBridge, Emerson, Schroff
  - New full rack power system with IPMI from Schroff
- Tutorial Demos in front of full meeting well received
- Medical X-Ray Tomosynthesis real-time scanner on ATCA (TripleRing Technologies)
  - Uses massively parallel processing chips on extra long board
  - Prototype in layout, trying to keep to standard ATCA format

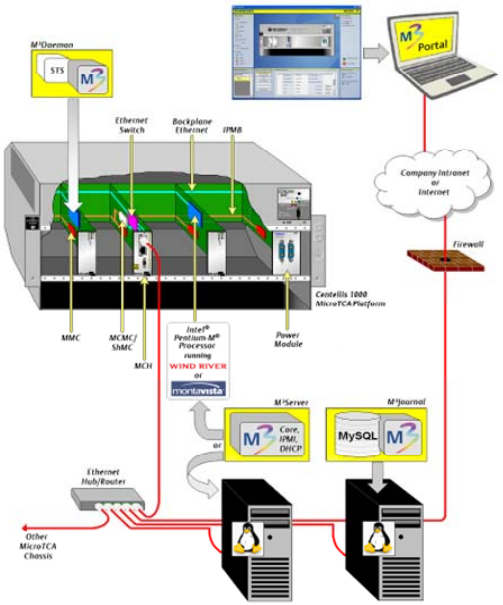
µTCA Chassis solutions

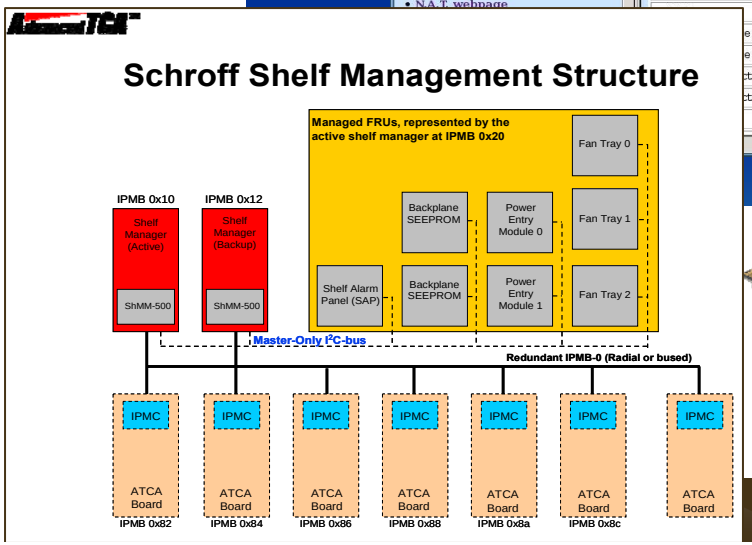
Performance Technologies





SpiderWare M3 Architecture View



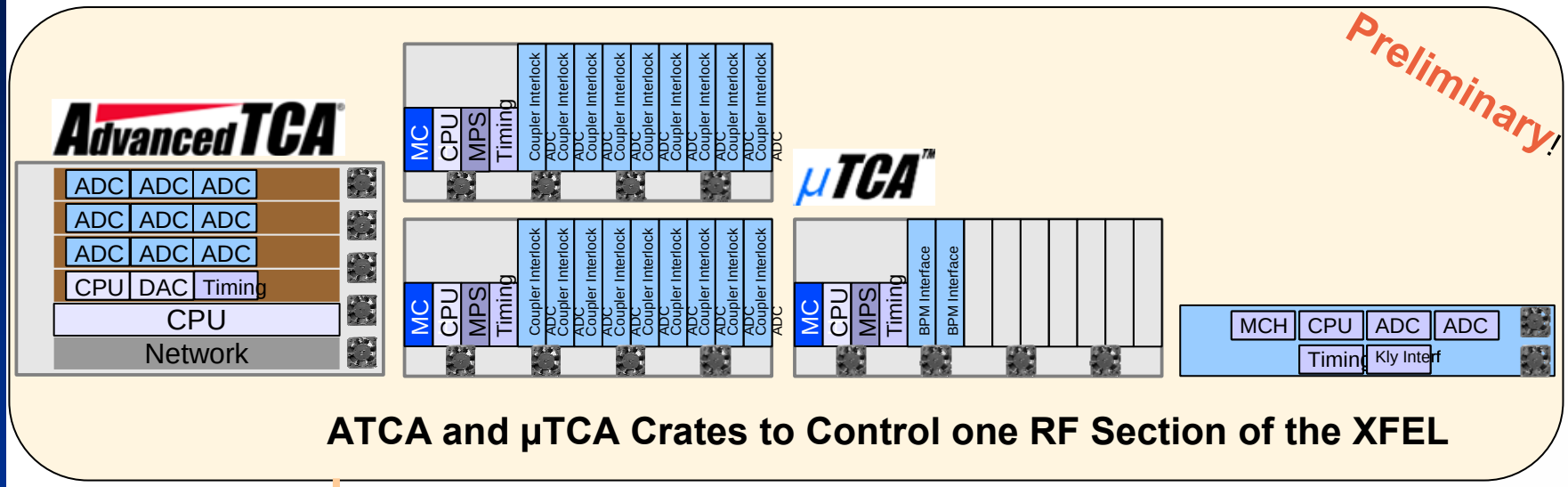


TEWS

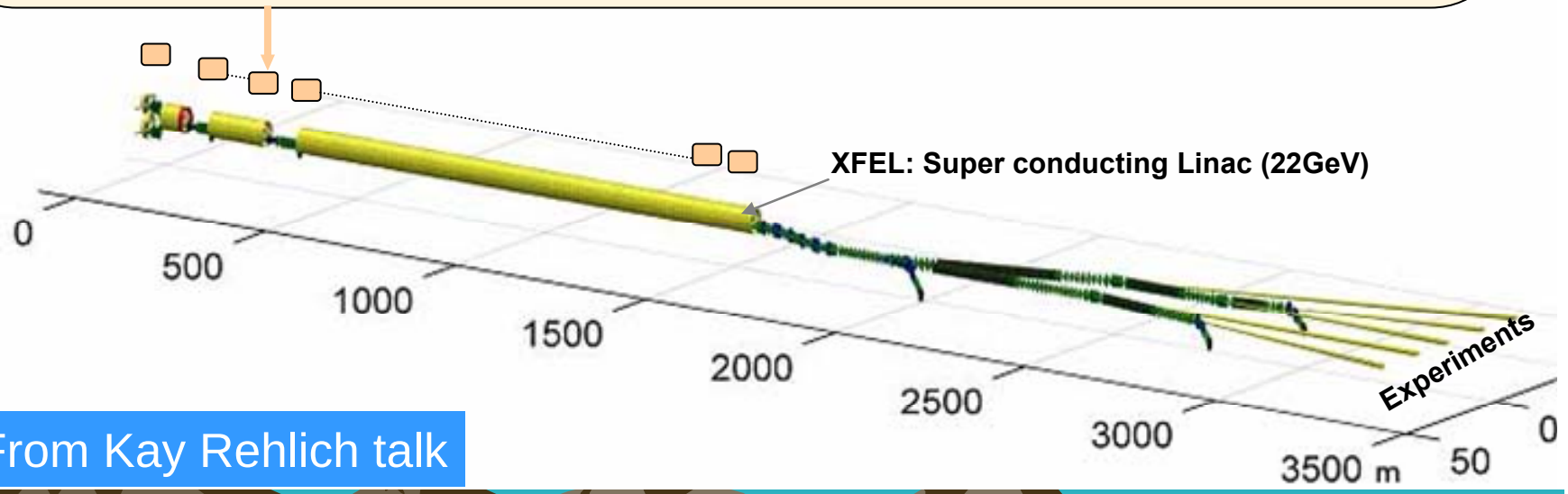
Contributed Paper Talks

- TC4-1: Evaluation and Developments of xTCA for a Large Accelerator
  K. Rehlich, DESY
- TC4-2: LLRF Control System based on ATCA for the European X-FEL
  T. Jezynski, University of Lodz
- TC4-3: Interfaces and Communication Protocols in ATCA-based LLRF Control Systems
  D. Makowski, University of Lodz
- TC4-4: ATCA-based Control System for Compensation of SC Cavities Detuning using Piezoelectric Actuators
  K. Przygoda, University of Lodz
- TC6-1: Redundant Controller Configuration Software for ATCA System at STF/KEK
  A. Kazakov, SOKENDAI, Tsukuba
- TC6-2: Design and Implementation of FPGA-Based Compute Node for the PANDA Experiment
  A. Liu, Chinese Academy of Science
- TC6-3: Application of SysML for Design of ATCA- Based LLRF System
  M. Greki, DESY
- TC6-4: Analog and Digital Signal Distribution in ATCA Crate for LLRF System for EU-XFEL
  K. Czuba, DESY
- TC6-5: Prototype AdvancedTCA Carrier Board with Three AMC Bays
  A. Zawada, DESY

Geographical Layout of RF Stations



ATCA and μTCA Crates to Control one RF Section of the XFEL



From Kay Rehlich talk

Contributed Presentation Highlights

- Many talks stemming from XFEL Accelerator Controls R&D
  - Front end controls, interlocks using variant MicroTCA shelf (non-redundant)
  - High BW LLRF system requires full ATCA card, carriers with complex interconnects from RTM area
  - Several talks on software interfacing & controls protocols, redundant controller configuration, SC cavity tuning controls, analog/digital signal dist'n
  - *Excellent progress on HW,FW,SW, performance*
- Physics DAQ R&D
  - IHEP High BW DAQ FPGA-based compute node on full ATCA board for PANDA experiment

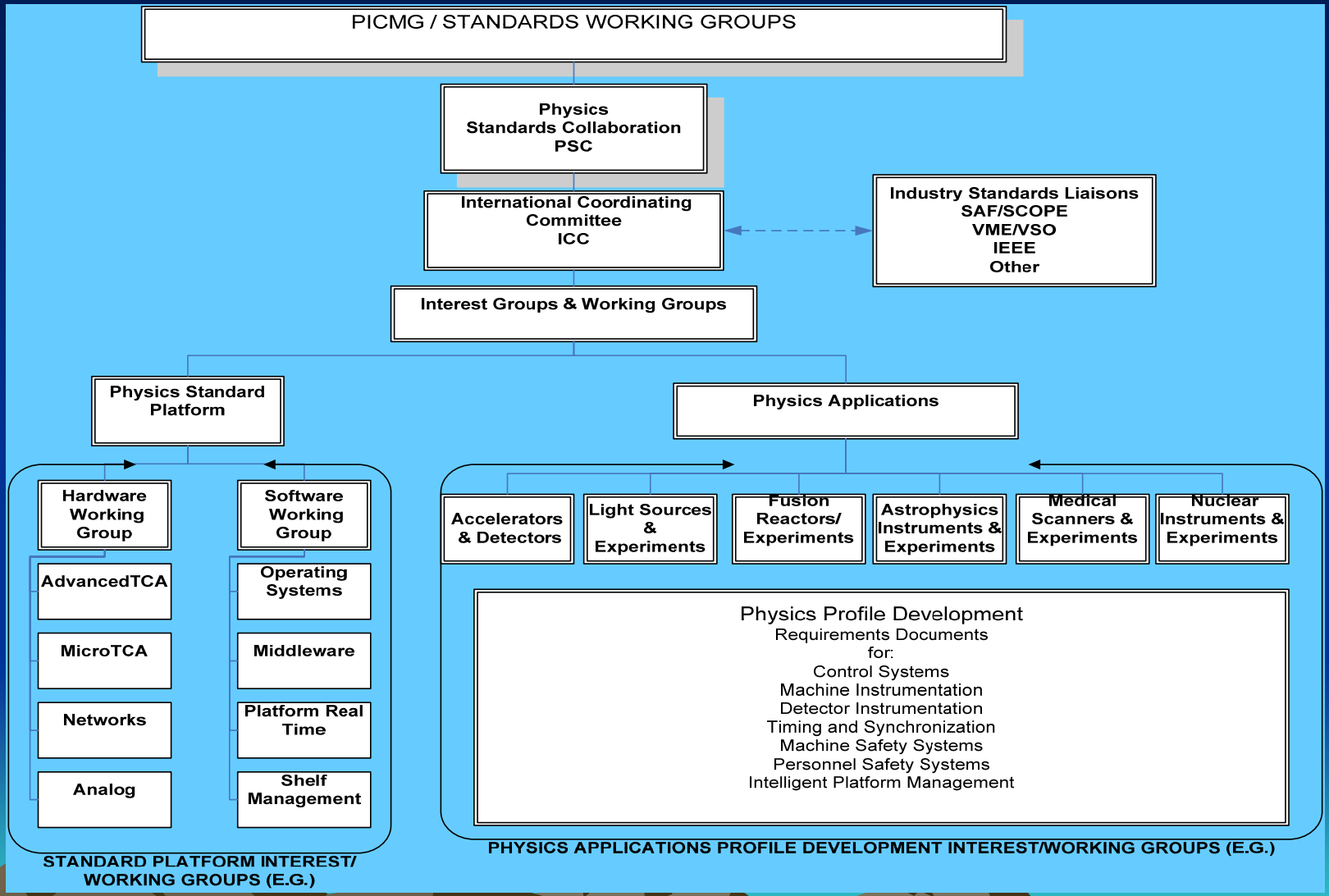
Appended Reports

- ATCA-VME Adapter at SLAC/SAIC
  - Graphics of very dense 18 layer board now in first fabrication shown by M. Chaubal, SAIC
- ATCA meeting in France
  - Tutorial meeting of 27 engineers working on or aspiring to work on ATCA projects described by P. LeDû

Standards Collaboration Discussion

- Possibility of forming xTCA for Physics Working Groups under PICMG, SAF and SCOPE presented (R. Larsen)
  - Many real issues identified, need addressing if labs to achieve useful level of *interoperable* hardware-software-firmware standard solutions
  - Standards participation by labs encouraged
  - Fees for lab modest to none
  - Draft xTCA Profile for Physics document reviewed
  - Audience encouraged to consider supporting, collaborating
  - Possible Physics WG Model block diagram is attached
- Follow-up
  - Develop interest group mailing list
  - Collaborate on planning future tutorials, workshops
  - Investigate web tools for meetings

Physics Standards WG Model



Summary & Next Workshops

- Dresden Workshop shows growing activity & interest
  - Lab activity in both DAQ and Controls
  - Strong interest in physics from manufacturers
  - ATCA, MicroTCA diversifying, growing IO functionality
- Next Workshops/Tutorials
  - May 2009 IEEE Real Time Controls Conference, Beijing
  - Summer European meeting, location TBD
  - October 2009 NSS-MIC Conference, Orlando FL
- Standards Collaboration Development
  - *Dresden Workshop proposed developing xTCA standard extensions for physics applications under PICMG Working Group via Physics Profile Draft Document; collaboration with industry*
  - *Plans proceeding to implement working group under PICMG*