Crate Standards for LLRF

Jaroslaw Szewinski

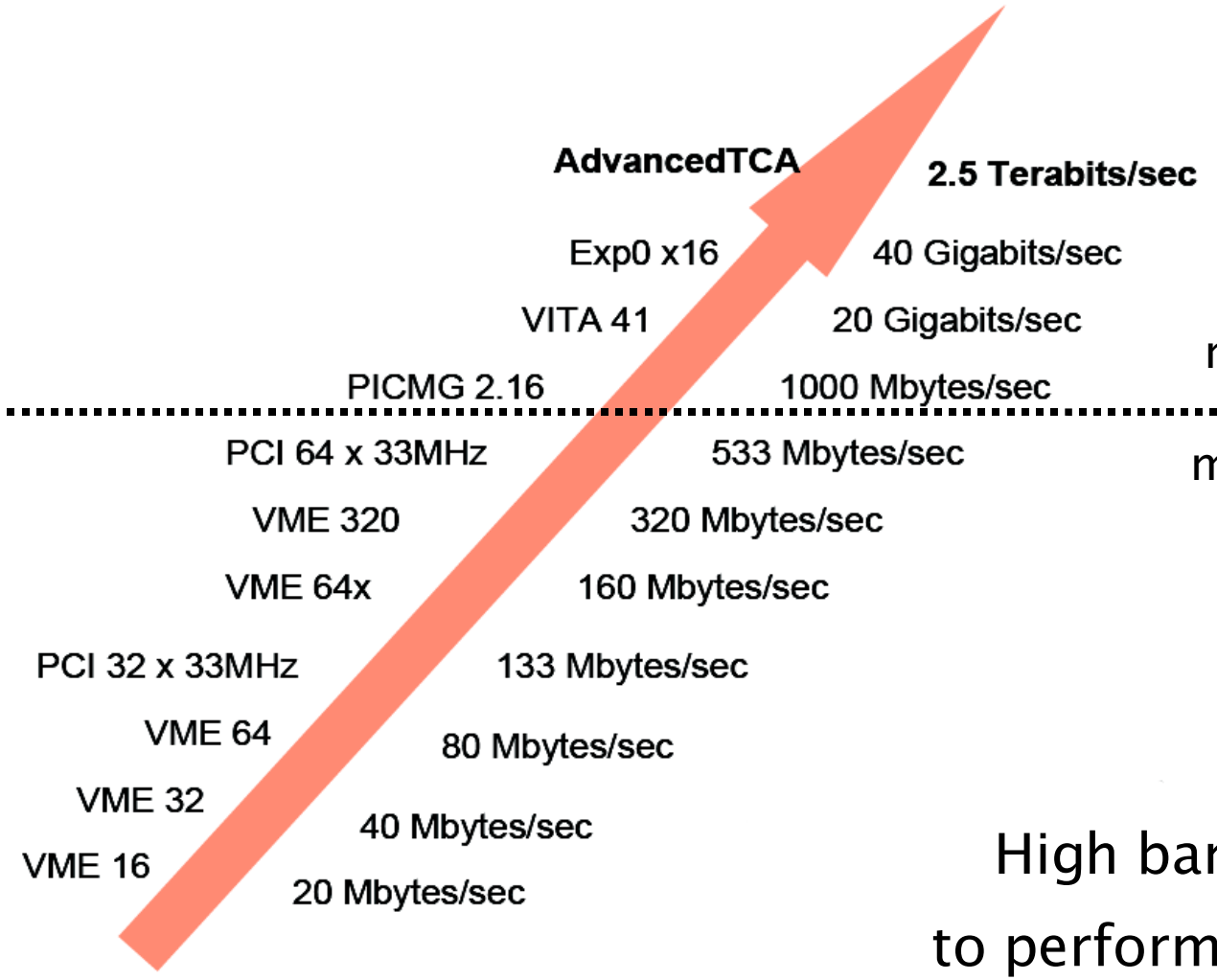
Agenda

- LLRF Requirements for crates
- Crates evolution and trends
- Backplane topologies in case of LLRF
- Crates standards, history and overview
- VITA vs. PICMG
- VPX vs. ATCA
- Features unique for ATCA

LLRF Requirements for crates

- Multi channel control require concentration of large amount of analog signals (today 14-16 bit each) in one place, due to perform vector sum calculation. There will be 96 signals per one klystron in X-FEL - it must be multi-board system (crate needed)
- To reduce number of boards in the crate, large sized PCB boards are preferred
- Since signals are distributed over several ADC boards, crate must provide fast communication on backplane to handle on-line feedback
- Crate must be a reliable platform for electronics, to achieve high availability of LLRF systems, and whole machine.

Crates evolution- bandwidth



serial differential
mesh/star backplanes

multi-drop backplanes
parallel bus

High bandwidth is needed
to perform on-line feedback

Market trends – everything goes serial

PC technology:

PCI => PCI Express (PCIe)

ATA => Serial ATA (SATA)

SCSI => Serial Attached SCSI (SAS)

Crates:

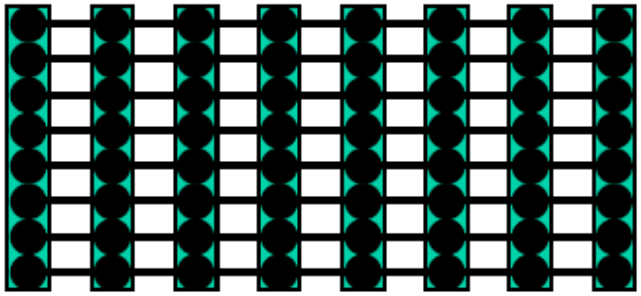
cPCI => **ATCA (PICMG 3.0)**

cPCI Express (**PICMG EXP.0**)

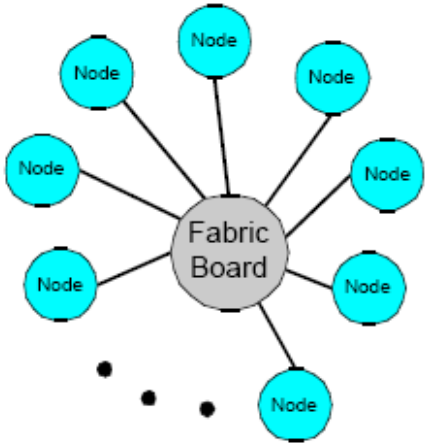
VME => VPX (VITA 46)

VXS (VITA 41),

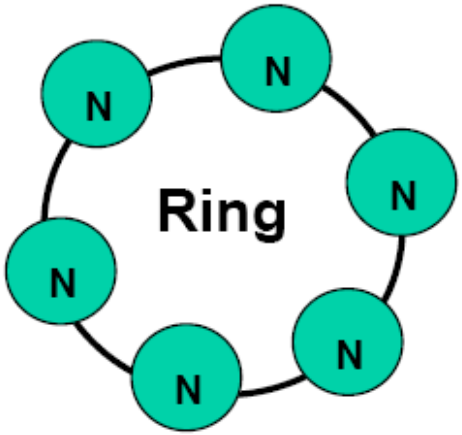
Fabric topologies



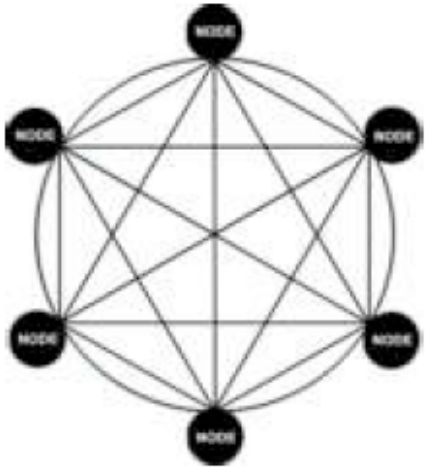
Multi-Drop Bus



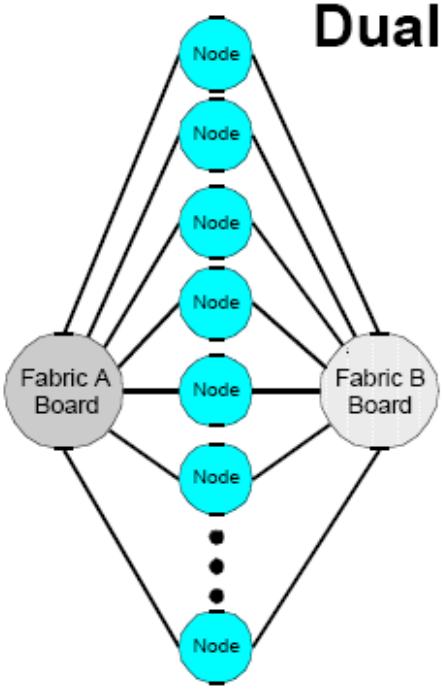
Star



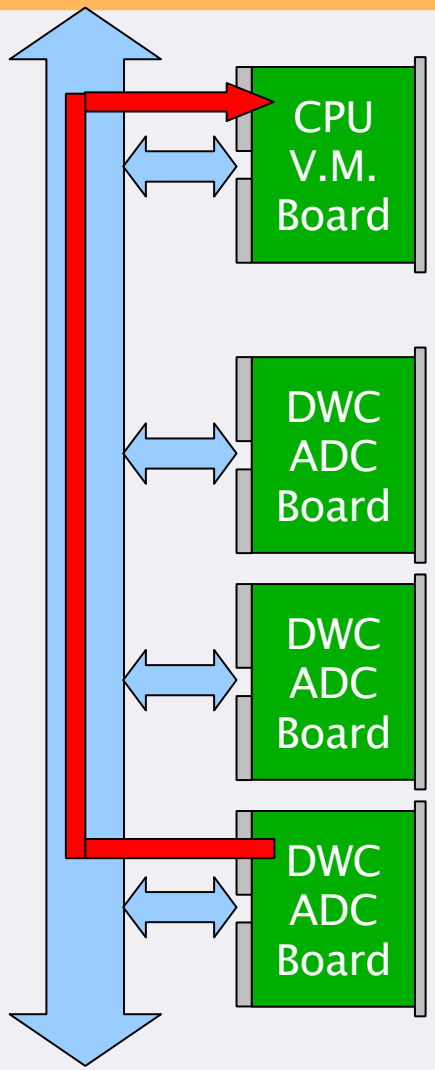
Mesh



Dual Star



Multi- drop bus vs. Star/ Mesh in LLRF



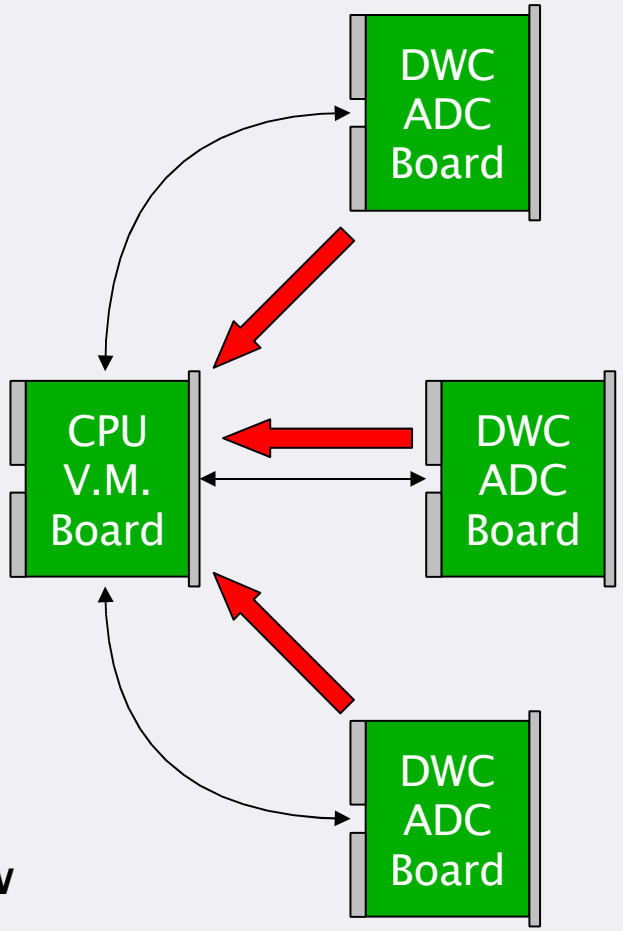
In multi-drop bus,

only one ADC board can send data for vector sum calculation, at same time.

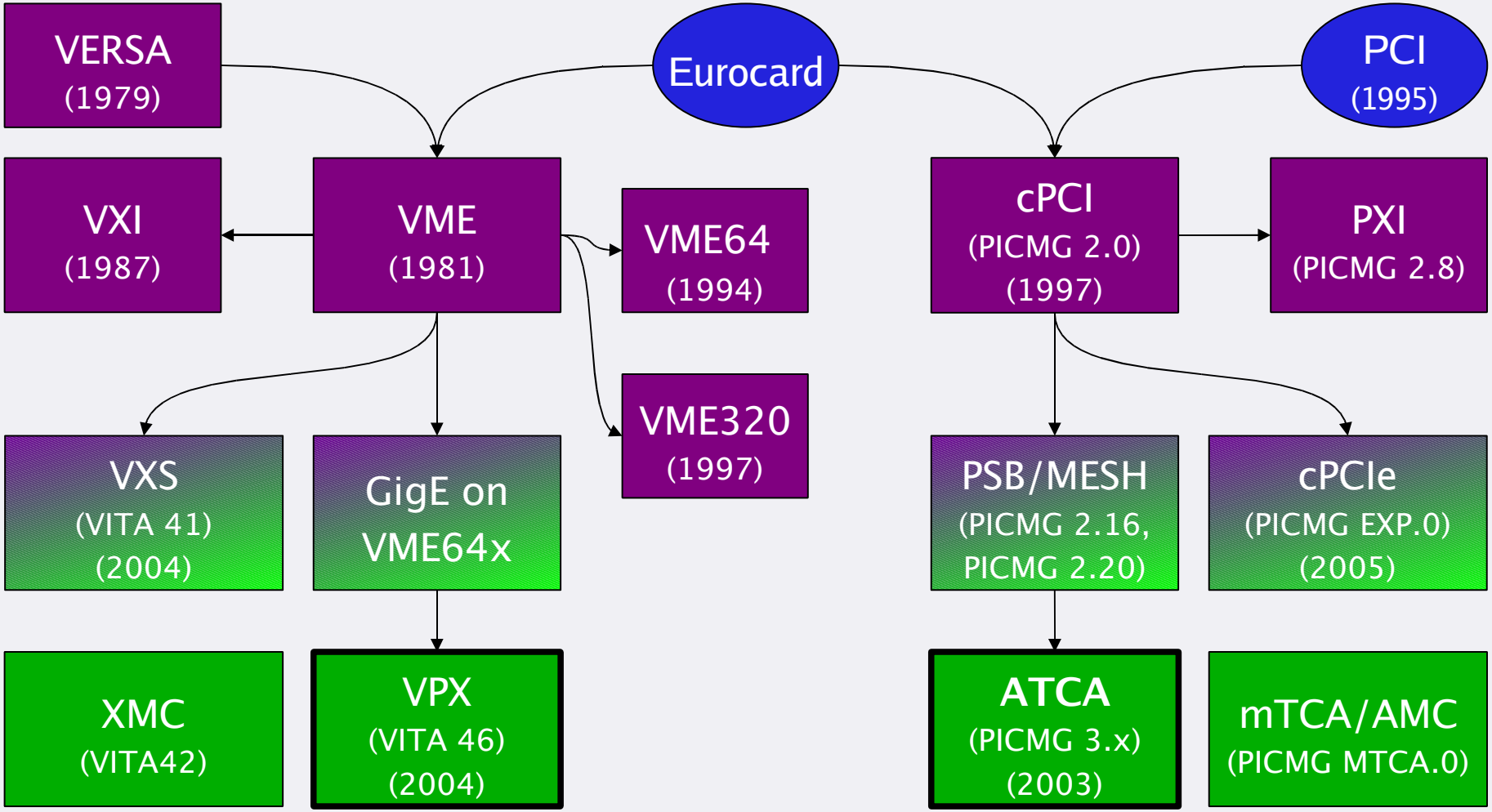
In mesh or star topology

ALL ADC boards can send data simultaneously to the processing unit.

This is needed to make low latency feedback.



Crate standards, history and overview



Crates classes

- **VME, cPCI** – parallel multi-drop buses
- **VXI, PXI** – extensions of VME and cPCI for instrumentation
- **VXS, GigE on VME64, PICMG 2.16 -2.20 (PSB, StarFabric, Serial Mesh), cPCIe** –hybrid solutions, cPCI or VME backplanes with additional serial LVDS links (in various topologies), still backward compatible to VME or cPCI.
- **ATCA, VPX** – pure hi-speed serial backplanes, connectors not compatible backwards, only point-to-point connections, no multi-drop buses –topologies: star, dual-star, mesh instead.

VITA vs. PICMG

- PICMG made in 1997 cPCI, and in 2003 ATCA was announced – a new standard has been designed to utilize the performance of LVDS serial links on the backplane, without strong need for backward compatibility.
- VITA has been providing VME crates for over 20 years, so their new standards must be somehow backward compatible were possible, to be able to make upgrade of an old VME installations (replace VME backplane in the chassis for VPX backplane), VME and VPX has same board sizes – 6U x 160mm.
- X-FEL (and possibly ILC) is a new project (not an upgrade), so now any standard can be chosen, backward compatibility is not a problem. In 2011, close to X-FEL commissioning, VME will be 30 years old technology.

VPX vs. ATCA

VPX (2004)

- VITA's answer for ATCA
- Standard not ready yet (generally, only backplane specification)
- IPMI shelf management based on ATCA (VITA 38 spec. is based on PICMG 2.9 spec.)
- Keeps the 'VME spirit' – same board factors, connectors are not compatible, but optionally VME signals can be provided on backplane

ATCA (2003)

–A true revolution in crates

- Standard is not closed yet, but key features are well described
- IPMI shelf management adopted from computers (servers)
- Not compatible backwards with other crates, but can fully utilize LVDS based communications.
- PCI devices can be easily attached via PCI-to-PCIe bridges

Features unique for ATCA

- Large PCB size, can handle 24 or 32 channels, which makes possible to handle all 96 signals with 3 or 4 boards
- Complete solution for system diagnostics and shelf management based on IPMI
- High availability, achieved by combing hot-swap and redundancy of key hardware components (power supplies, fans, shelf managers, boards, etc), and redundancy of connections (dual IPMI I2C bus, dual-star and mesh topologies)

References

http://www.picmg.com/

http://www.vita.com/

http://www.interfacebus.com/

http://www.nextgenbackplanes.com/

http://www.bustronic.com/

http://www.elma.com/