AMC13 Project

Status

E. Hazen - Boston University
for the CMS Collaboration
What is AMC13?

- It is not an MCH! It is a 13th AMC in MCH-2 slot
- It distributes LHC clock / timing / controls to AMCs
- It collects DAQ data from AMCs
- It provides standard interface to CMS subdetectors:
  - CMS DAQ via optical fibers (currently 2 at ~ 6Gb/s)
  - TTC via 1300nm fiber @ 160Mb/sec biphase mark code
    - Future TTC upgrade may be supported via spare SFP site
  - TTS via 1300nm fiber with protocol t.b.d.
- It is expected to evolve somewhat to comply with evolving new standards from central services
CMS uTCA Readout Crate (i.e. HCAL)

- 12 AMC Slots
- Commercial MCH Management Ethernet
- AMC13 Clocks Fast controls DAQ

- Fiber links from detector i.e. GBT
- Fiber links to trigger

- Legacy TTC
- Upgraded Timing Fast Controls
- DAQ optical fiber
**AMC13 Board Stack**

- **Base configuration has only tongues 1, 2**
- **Base board - With optics and HS links (Fabric A)**
- **Clocks board - distributes LHC clock and controls**
- **Mezzanine connector for T3 with I2C**
  - **T3 has JTAG and LEDs**

**T3 board**
- Provides JTAG / LEDs on front panel
- Can be removed after initial programming

- Crosspoint switch or other custom board can be installed here (but see notes!)

**T1 base board**
- MMC functions (Wisconsin firmware)
- TTC optical rx
- 3x SFP+ cage
- Cross-over GbE from MCH1 for controls and local DAQ

**Connector to T3 provides:**
- Power
- JTAG (MMC and Xilinx)
- Utility SPI
- MMC serial console
AMC13 Hardware

- **Virtex-6 LX130T FPGA**
  - DAQ Functions, buffering
  - 6Gb links to backplane, SFP
- **SFP+ Sites**
  - 1 for TTC (160Mb)
  - 3 for DAQ/etc 6.2Gb
- **Spartan 6 FPGA**
  - Fabric B TTC distribution
  - Firmware management interface to MMC
- **Atmel AVR-32 uC**
  - MMC Functions
- **Tongue 1 PCB**
  - JTAG Headers
  - MMC programming
  - FPGA programming
- **Tongue 2 PCB**
  - Micro USB
  - MMC serial console
- **Tongue 3 PCB**
  - (4) SFP+ Sites
  - 1 for TTC (160Mb)
  - 3 for DAQ/etc 6.2Gb
  - Optional, for initial programming
AMC13 in VT892 Crate

- AMC13 in MCH2 site
- Commercial MCH (Dummy Module)
- Custom AMC (HCAL MiniCTR2)
CMS AMC13 Module Block Diagram

- **TTC in TTS out**: SFP
- **DAQ 6Gb/s**: SFP+, GTX
- **Spare**: SFP+, GTX
- **SFP+**: GTX
- **Gbps**: GTX
- **MCH1**: 2:1 Switch
- **GbE**: GTP
- **IPMI**: MMC uC
- **JTAG LEDs**: Flash
- **Front Panel via T3**: GTX
- **CLK F/O**: 128 Mbyte DDR3
- **40.xx CLK To AMCs**: GTX
- **Fabric A 12 ports ≤ 6 Gb/s**: GTX
- **Fabric B 80 Mb/s (TTC)**: GTX
- **Upgrade to ~ 320 Mb/s**: GTX
# uTCA Ports Use for CMS

<table>
<thead>
<tr>
<th>Fabric</th>
<th>AMC Port</th>
<th>MCH</th>
<th>AMC13</th>
<th>Category</th>
<th>MCH Finger</th>
<th>CMS Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0</td>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
<td>GbE</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td></td>
<td>Yes</td>
<td></td>
<td>1</td>
<td>DAQ</td>
</tr>
<tr>
<td>B</td>
<td>2</td>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
<td>Spare</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td></td>
<td>Yes</td>
<td></td>
<td>2</td>
<td>Fast controls (TTC)</td>
</tr>
<tr>
<td>Clock</td>
<td>TCLKA</td>
<td>CLK1/2</td>
<td></td>
<td></td>
<td></td>
<td>Spare</td>
</tr>
<tr>
<td></td>
<td>FCLKA</td>
<td>CLK1/2</td>
<td></td>
<td></td>
<td></td>
<td>LHC Clock</td>
</tr>
<tr>
<td>D-G</td>
<td>4-7</td>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
<td>Fat Pipes</td>
</tr>
<tr>
<td></td>
<td>8-11</td>
<td></td>
<td>Yes[2]</td>
<td></td>
<td>3, 4</td>
<td>User</td>
</tr>
<tr>
<td>H-K</td>
<td>12-15</td>
<td></td>
<td></td>
<td></td>
<td>Extended Fat Pipes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>16-19</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**

1. Port 1 (DAQ link) will be operated at a multiple of the 125 MHz GbE reference clock (2.5, 3.125, 5.0GB/s) in the AMC13 reference firmware. AMC designers are advised not to count on this... certain users may prefer to use the LHC clock as a reference for port 1.

2. “Fat pipes” fabrics D-G are routed to the T3/T4 connectors of the AMC13 but the standard AMC13 does not make any connection to these tongues. Users may implement their own boards. Contact me for details!
μTCA Dual-Star Backplane

Note: Interconnections can be customized by the backplane manufacturer inexpensively.

- **Fabric A (1 link)**
  - Gigabit Ethernet

- **Fabric B (1 link)**
  - Spare

- **Fabric D-G**
  - Spare

- **CLK1**
  - Spare

**Bi-directional serial (up to 10Gb/sec) point-to-point links from each AMC to MCH**
*(redundant links to each MCH)*

**CMS Use**
- Fabric A (1 link)
  - DAQ @ 2-4 Gb/s

- Fabric B (1 link)
  - LVDS TTC

- Fabric D-G (4 links)
  - Spare

- CLK1
  - MLVDS LHC clock

**MCH 1**
- Commercial /Std

**MCH 2 aka “AMC13”**
- Custom design for CMS
**TTC / Clocks**

- **SFP**
  - 1300nm receiver (ATM type)
  - Compatible with TTC fiber data

- **ADN2814 Clock/data Recovery IC**
  - Recovered Clock 160MHz

- **SY89832 Fanout**
  - Recovered Data 80 Mb/s

- **SY89872**
  - Divide by 2/4
  - 160MHz

- **SY89832 Fanout**
  - 40MHz

- **DS91M125 1:8 Fanout**
  - 40MHz Clock
  - To uTCA backplane

- **Spartan 6 LX130T**
  - Spartan 6 FPGA re-times TTC data to match 40MHz clock phase
  - (local TTC decoder also implemented to provide L1A, BC0 etc in AMC13)

- **Note: no TTCrx ASIC required!**
MicroTCA Interface to CMS (Interim)

- SFP+ New DAQ receiver card to S-Link, Myrinet, etc
- SFP+ SFP+ SFP+
- AMC13
- SFP
- TTCex
- OptRx
- OptRx
- OptRx
- FPGA
- FMM Adapter
- RJ-45 To FMM
- Gigabit Ethernet(s) DCS Controls

Data to DAQ ~ 6 Gb/s
1 or 2 links per crate
160 Mb/s
In: TTC
Out: TTS

Central CMS DAQ
TTC System

To FMM
MicroTCA Interface to CMS (Ultimate)

AMC13

SFP+
SFP+
SFP

Data to DAQ
~ 10 Gb/s
10Base-SR/LR

Protocol TBD

Data encoding and clock scheme TBD

PON fanout ??

Standard PC
10GbE NIC

NIC
NIC

Central
CMS
DAQ

Replacement
for TTC System

Replacement
for TTS System

Gigabit Ethernet(s)
DCS
Controls

MCH

E. Hazen -- xTCA IG
2011-09-27
Status and Schedule

- 3 prototypes assembled and under test
- 8 more boards will be produced by end October 2011
- Initial Firmware development:
  - MMC (AMC standard plus useful extensions) by University of Wisconsin
  - Ethernet interface with IPBus / MicroHAL by Minnesota, Bristol, others
  - TTC / Clock distribution by Boston University
  - Flash programming via GbE
  - Prototype/demo DAQ for CMS HCAL
- First 3 items available by ~ Nov 2011
Highlights for Potential Users

- Documentation at [http://www.amc13.info](http://www.amc13.info) including draft crate/protocol definition document
- Backplane ports use and protocol (under) specification
  - If AMC designs comply with specifications, interface to i.e. CMS central systems is handled by AMC13
- MCH tongues 3, 4 available for users, i.e. for crosspoint switch.
  - Current no standard for T2/T3 connection :( so, commercial T3/T4 cannot be used.
Backup / Review Slides
Clocking Issue

- AMC13 provides LHC clock (40.xxx MHz) on MicroTCA CLK1.
- “Redundant Clock” Vadatech backplane routes this to AMC CLK3 (FCLKA).
- Some users have proposed to use commercial AMC which requires a 100MHz PCIe clock on this pin.
- This is incompatible with AMC13 clock scheme
**DAQ Interface Upgrade**

- We've invented a simple fiber-based demonstration protocol for DAQ for AMC13 hardware testing (and possible HCAL TB use). This protocol can use two fibers per AMC13 (two HCAL FEDs).

- Tested extensively at 5Gb/s in lab using HCAL DTC board and Xilinx SP605 PCIe eval board

  - This board will be mounted in a PC with at least some software support (by us) for PCIe readout of DAQ data

- We are working with the CMS central DAQ group to develop interim and ultimate solutions for the DAQ link.