On-board PCs for interfacing front-end electronics

JCOP team meeting

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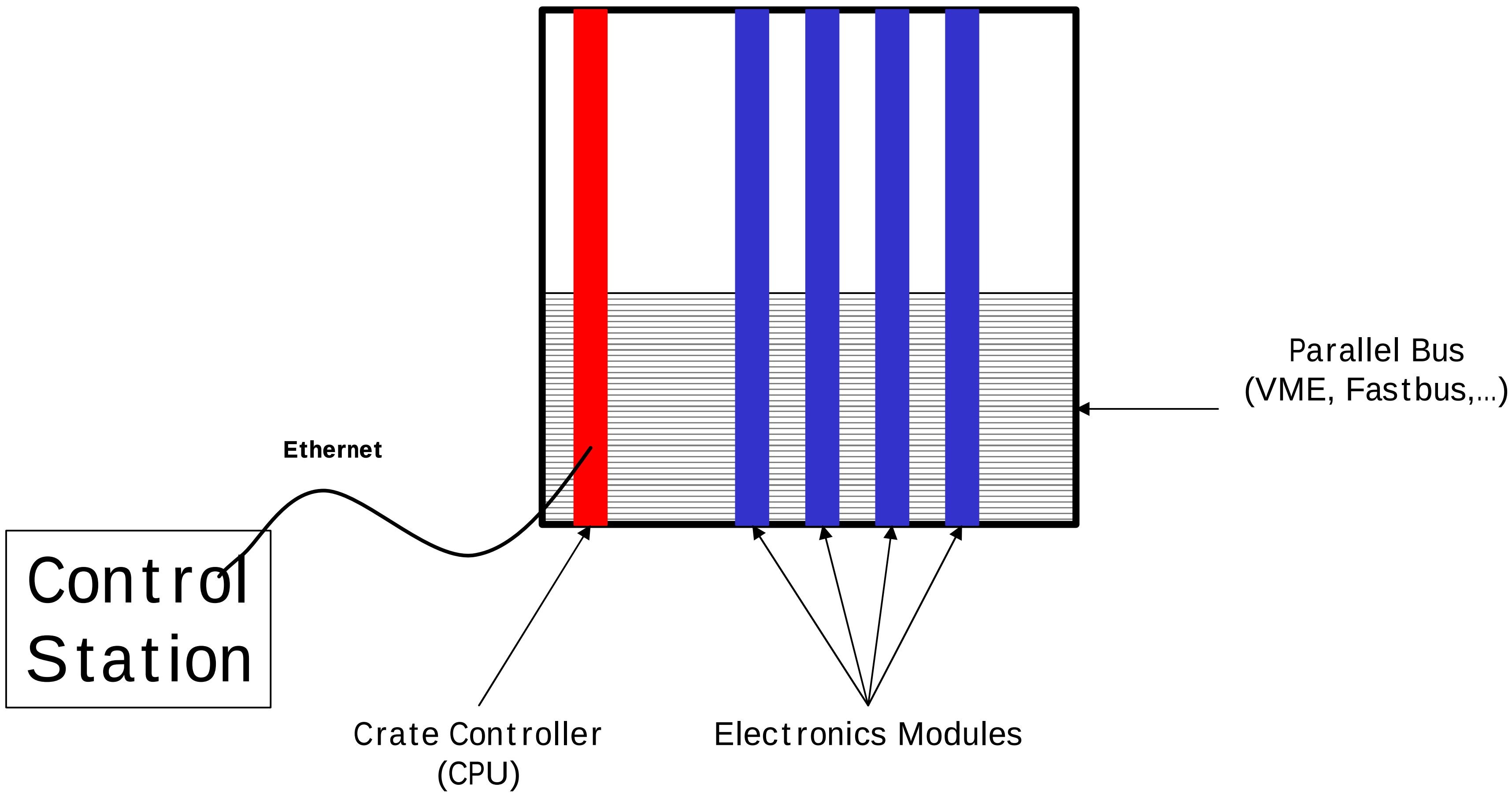
Niko Neufeld

CERN/EP

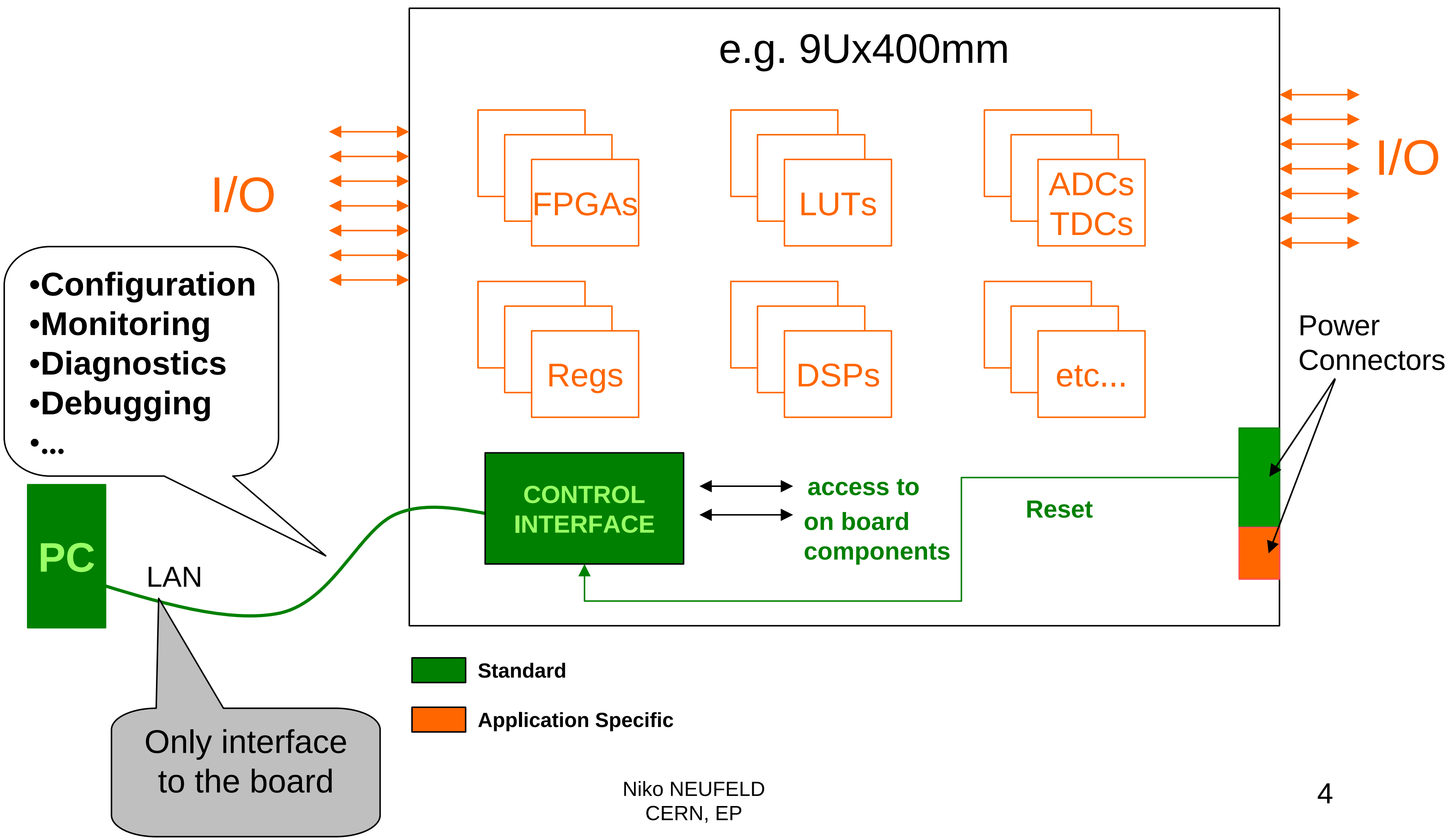
Controlling Boards
The traditional approach



Traditional board control

- Bus based control system
- Each board in a crate is controlled via a bus (VME etc.) either by a dedicated crate processor (e.g. RIO) or has a dedicated interface to a remote processor (usually a PC)
- The crates can be chained via a bus interconnect
- The crate processor is connected to the control system via a LAN (Ethernet)
- The main disadvantages are that
  - a faulty module can block access to a whole crate/chain
  - the faulty module is difficult to isolate once the bus is blocked
  - the crate processors / local interface - PC combinations are expensive

Point-to-point board control



Board control without a bus

- Each board has a single point-to-point connection to the control system
- 100 MBit Ethernet provides lots of bandwidth at a negligible cost (switch ports ~ 40 CHF)
- Embedded PCs provide a versatile local entry point on each board
- Many (20 to 50) embedded PCs can be booted, configured and controlled from a single Control Server PC

Commercial embedded PCs

- Small embedded PCs built around micro-controllers
- Many products based on various core chips, 1 BCHF market, growing fast
- Applications include: Web terminals, settop boxes, embedded Web servers, digital TV with integrated Internet browsers, switching stations, *electronic telephone books*, *navigation systems*, passenger entertainment, onboard Internet terminals, *ATMs*, vending machines, information terminals , heart monitors, *blood analyzers*, brain activity analyzers, X-ray equipment, computer-aided tomographs, data loggers, machine controllers, programmable logic controllers (PLCs), *mobile data input devices*, flight calculators for unmanned flight equipment, communications servers, and additional extremely rugged military applications

LHCb requirements

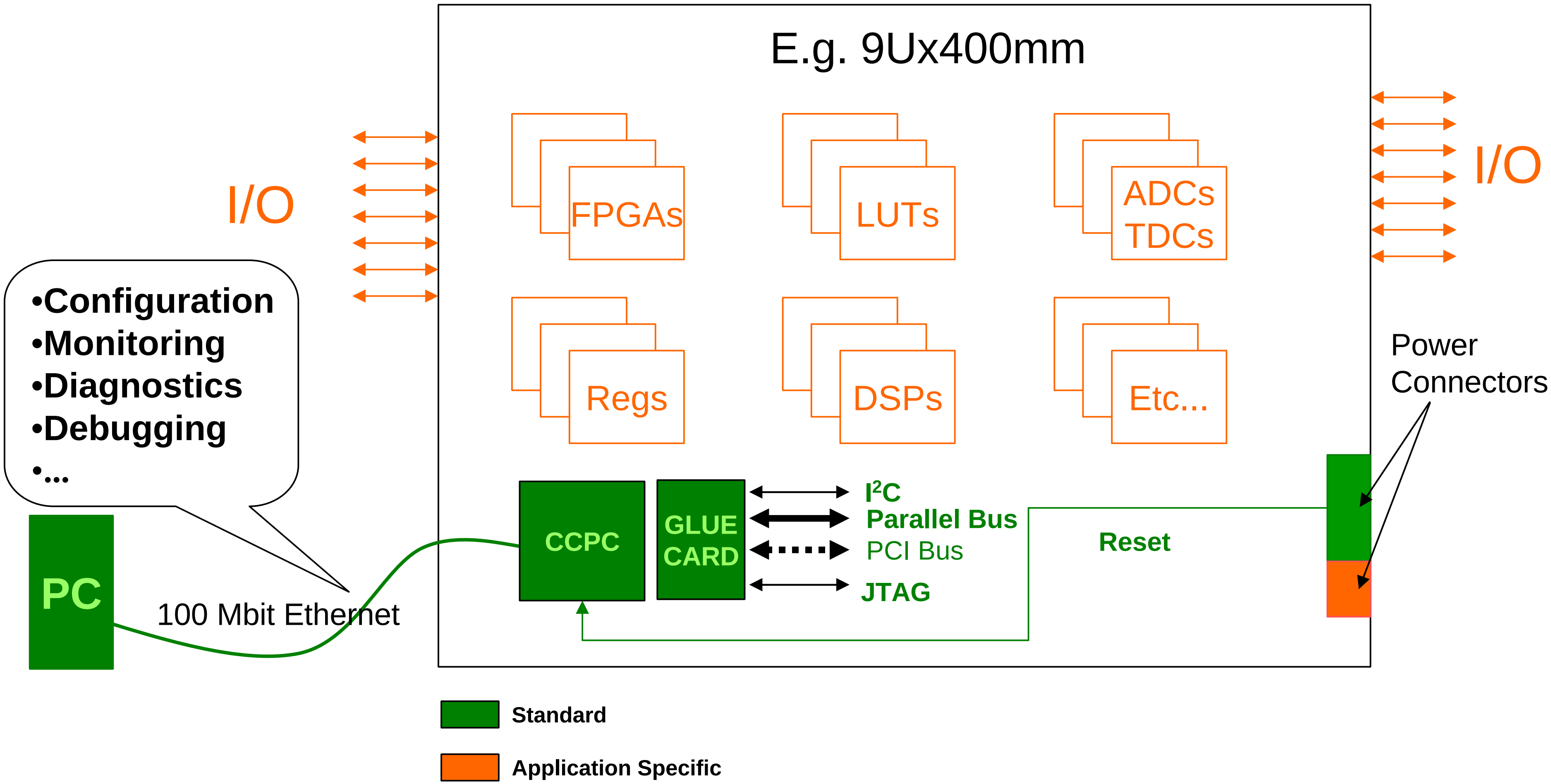
- The embedded PC must be accessible via standard 100 MBit Ethernet
- We have identified and recommended three main ways to configure and monitor devices such as FPGAs, DSPs and other chips:
  - I2C, JTAG and a simple parallel bus

Other ways are in principle possible (with some reservations) but discouraged: e.g. PCI or ISA

The LHCb choice

- Surveying the market for suitable (small, cheap) commercial devices brought forth an excellent candidate ☺
- SM586 by Digital Logic: Credit Card size module [66x85x6 mm] built around PC on-a-chip ZFx86 (low power Pentium compatible core @ 133 MHz), ~ 250 CHF in quantities
- Includes all standard PC interfaces: RS232, ISA, EIDE, PCI, USB
- Plus add-ons dedicated for embedded applications: Onboard Flash RAM for primary OS boot, I2C, BIOS control via serial line

Electronics board controlled by a Credit-Card PC



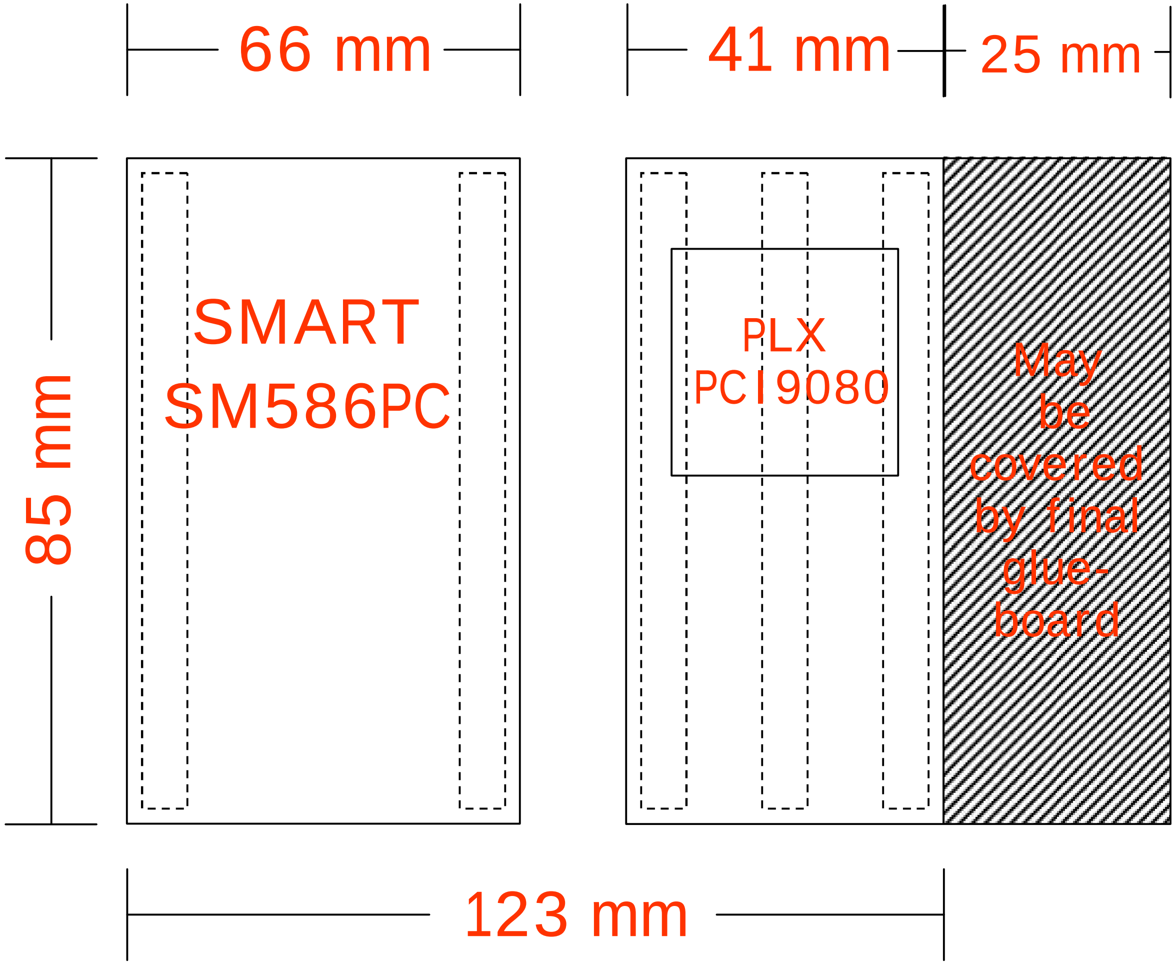
The LHCb solution for board control in non-radiation areas

- Use commercial Credit-Card PC as an interface
- Use a standard (home-made) glue-card to provide additional logic and provide a standard pin-out for developers
- The individual board (designer) needs to provide (apart from the board space) only one RJ45 connector on the front-panel and a connection to the reset-line (on the power-backplane)
- Optional extra connectors, if desired, could include: serial line, keyboard, JTAG header etc.

The LHCb standard glue card

- Prototype LHCb glue card connects to CCPC and provides
  - JTAG (from parallel port via Altera ByteBlaster)
  - Parallel local bus via PLX PCI9080 bridge
  - Level adaptation for serial port
- Final glue card (under design) could provide
  - more JTAG and I2C interfaces (necessitates additional decoder logic on ISA bus)
  - simpler (cheaper) PLX local bridge (e.g. 9030)

Mechanical layout of the Credit-Card PC



- Glue board is ~ 6 mm above PCB
- Could put shallow components beneath it

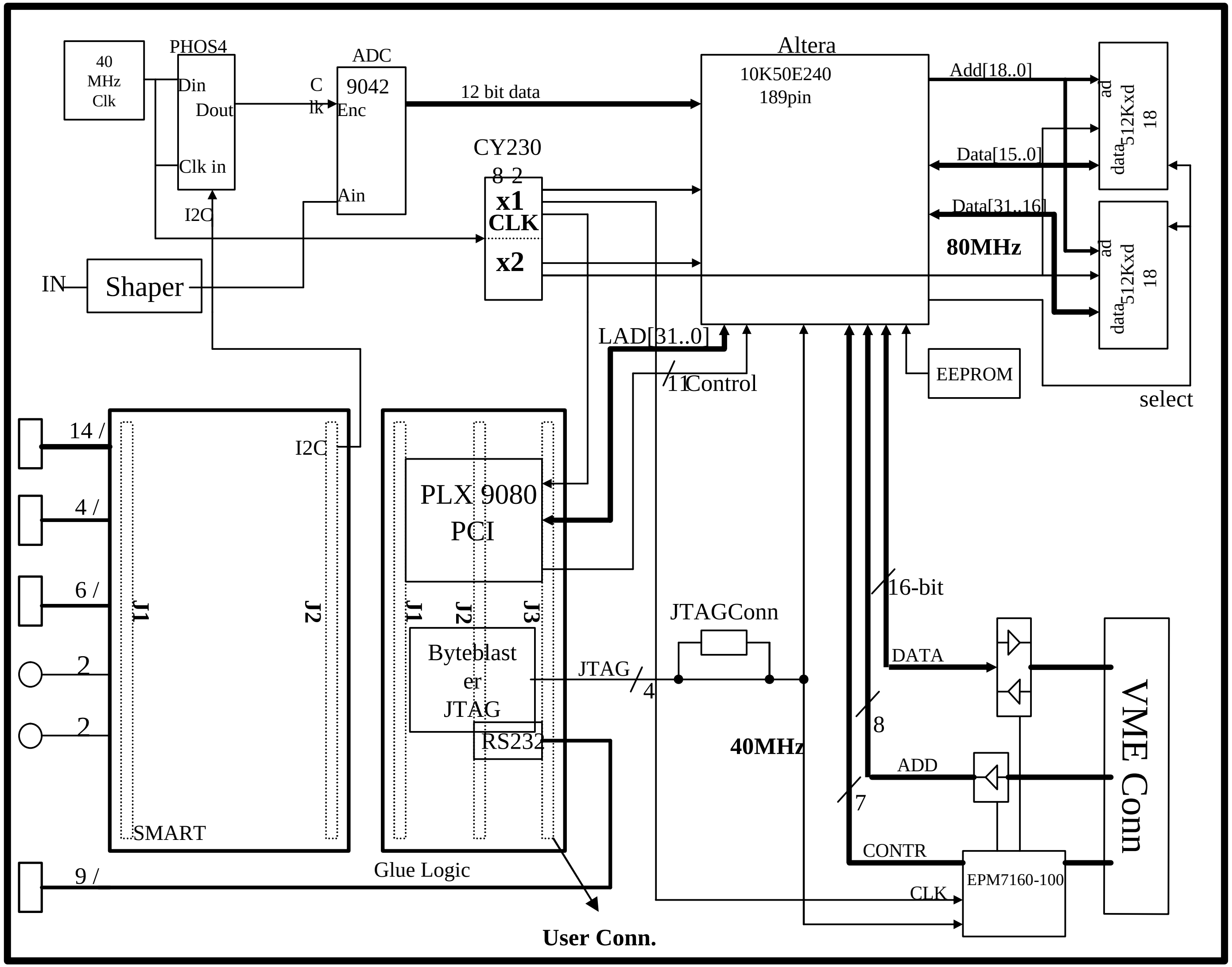
Central infrastructure

- Provide servers which give the Credit Card PCs access to NFS and logging services
- Provide customised OS for the CC-PCs (Linux – currently version 2.2.19)
- Provide drivers and (local) API libraries for I2C, JTAG and parallel bus and some specialised utility libraries (e.g. programming of FPGAs via standard STAPL files)

Integration into the LHCb Experiment Control System

- Framework Component provides
  - Remote access to local libraries/drivers (via DIM)
  - Predefined configurations ("macros" / "mini-components") for on-board devices (FPGAs, TTC devices, DSPs, delay chips, etc.)
  - Templates for user interfaces, panels

Status 1: the CC-PC evaluation Board



- 6U board comprising 2 MB of RAM, FPGA, CC-PC, Phos4 I^{2}C programmable delay
- FPGA to drive ADC and local bus; it is programmed via JTAG
- **Credit Card PC works: the OS boots from the internal flash RAM, runs from the network, can access board components**

Status 2 & immediate future

- Beta versions of most of the local APIs exis. The drivers for I2C and JTAG have already been extensively tested and demonstrated to work
- The local bus driver is currently being tested using our evaluation board
- The re-design of the glue-card is under way
- Plan to have “version 1” ready by 06/02