Status of PANDA DCS activities in Magurele - Part I -

Alexandru-Mario BRAGADIREANU, Dorel PIETREANU, Matei-Eugen VASILE

Horia Hulubei National Institute of Physics and Nuclear Engineering - IFIN HH

Status of PANDA DCS activities in Magurele
- Part I -

Contents:

1) PANDA DCS Architecture

2) Linux-Ready Embedded ARM boards as IOC's

- STT Gas System (RS-232);
- CAN Bus;
- USB Multifunction DAQ.

3) ATLAS ELMB128 board

PANDA DCS Architecture – centralized view

PANDA DCS

Magnets
- Solenoid
- Dipole

Targets
- Pellet Target
- Cluster Target
- Beam line & Interaction region

Silicon detectors
- MVD-Silicon Pixel Part
- MVD-Silicon Strip Part
- Luminosity Detector

Tracking System
- Straw Tube Tracker
- Endcap GEM
- Forward Trackers

Electromagnetic Calorimeter
- Barrel
- Forward Endcap
- Backward Endcap
- Forward Shashlyk

Charged Particle Identification
- Barrel DIRC
- Endcap Cherenkov
- Forward RICH
- TOF

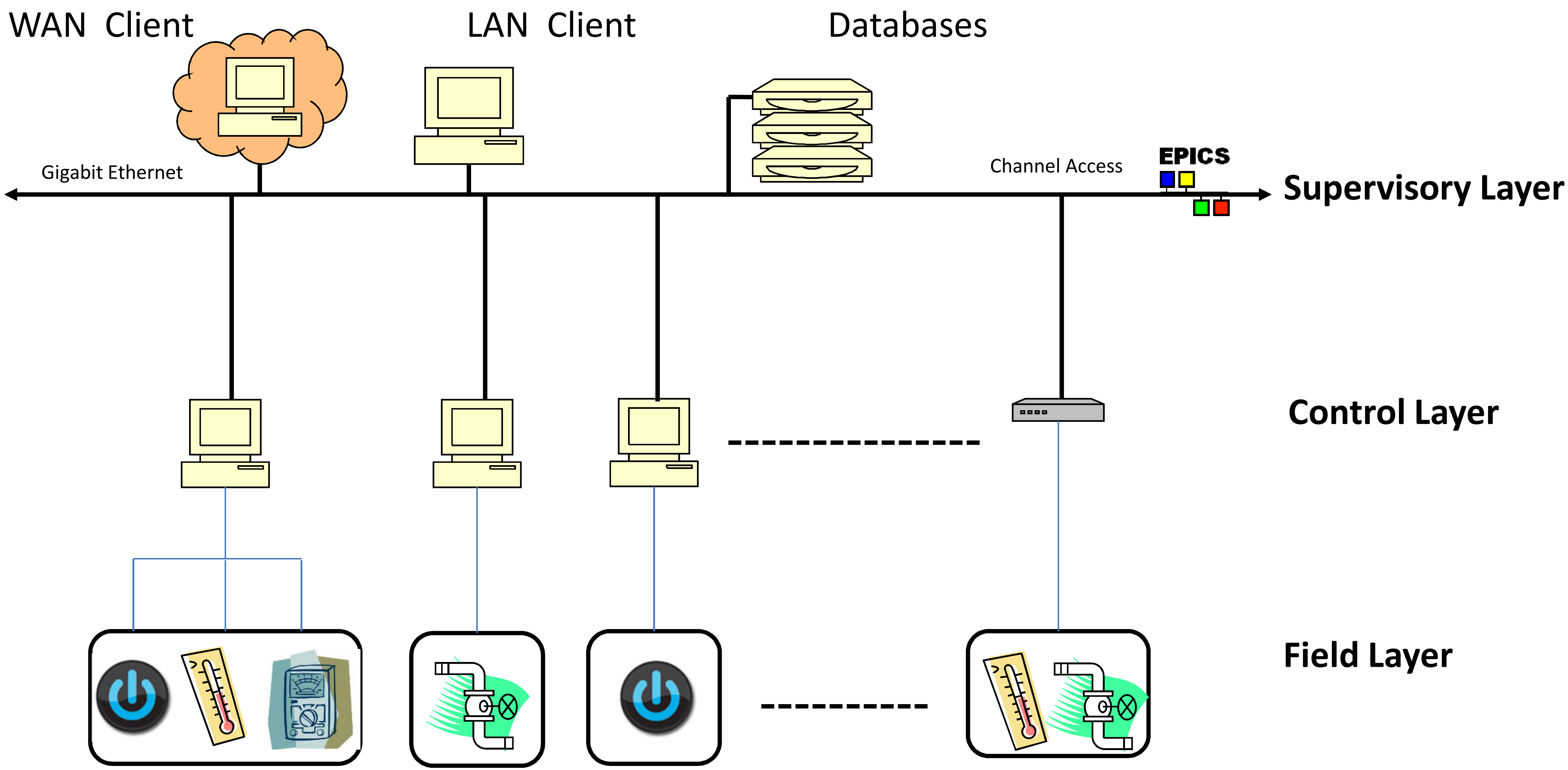
Hypernuclei Equipment

Muon System

Online systems
- DAQ
- Software trigger

Services
- Access & Safety
- Electricity, Cooling, Gas
- ……………………

PANDA DCS Hardware Architecture

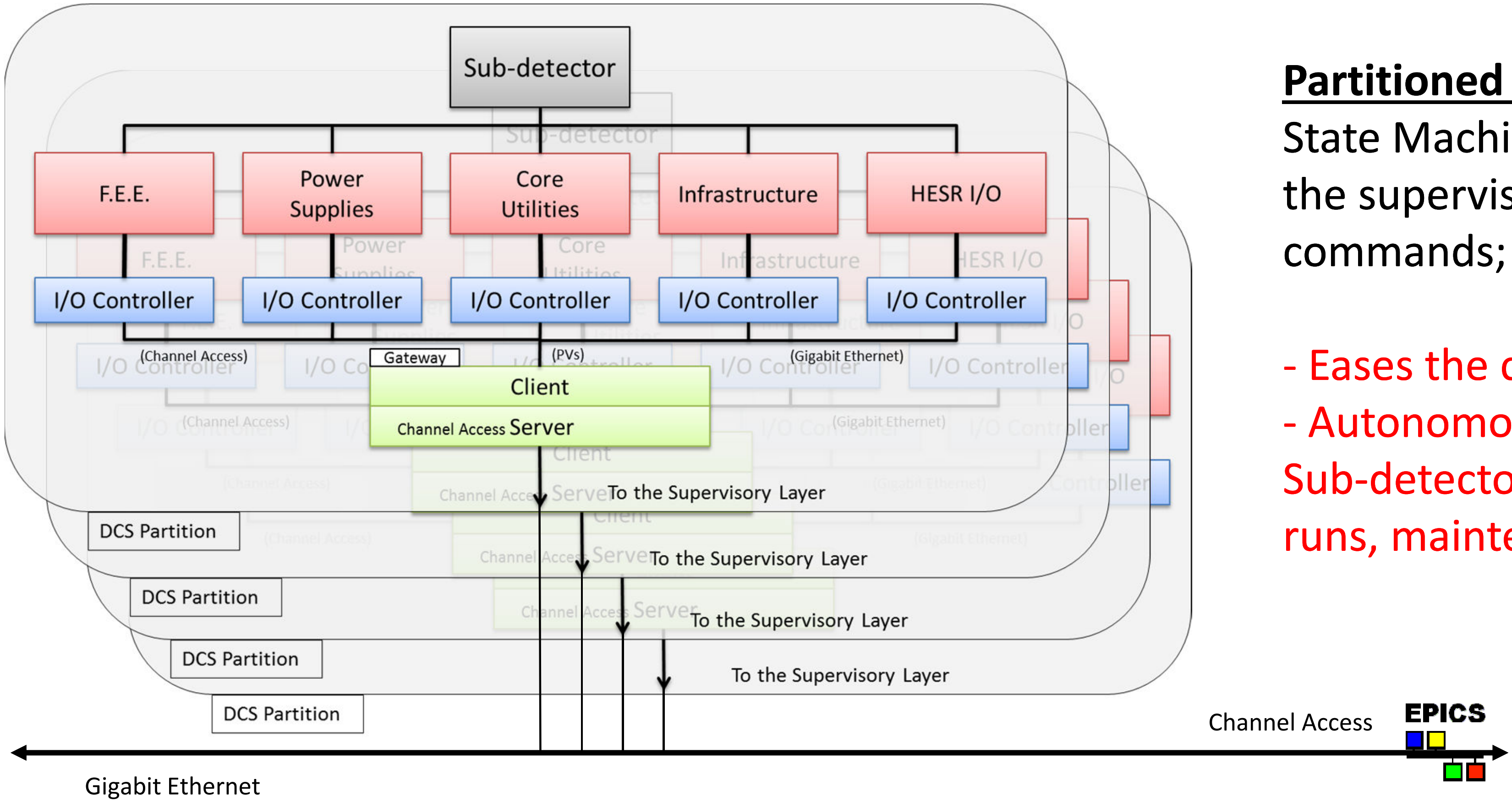


PANDA DCS Architecture - Complexity

Rough estimation of PANDA DCS complexity
16 sub-det., 2 magnets, targets, beam
↓
~ 100 sub-systems (~ 5 / sub-det.)
↓
~ 400 devices (~ 4 / sub-sys.)
↓
order of 10^4 "slow" channels

(Some) Requirements
- Scalable, Modular
- Graphical UI
- Non-expert operation

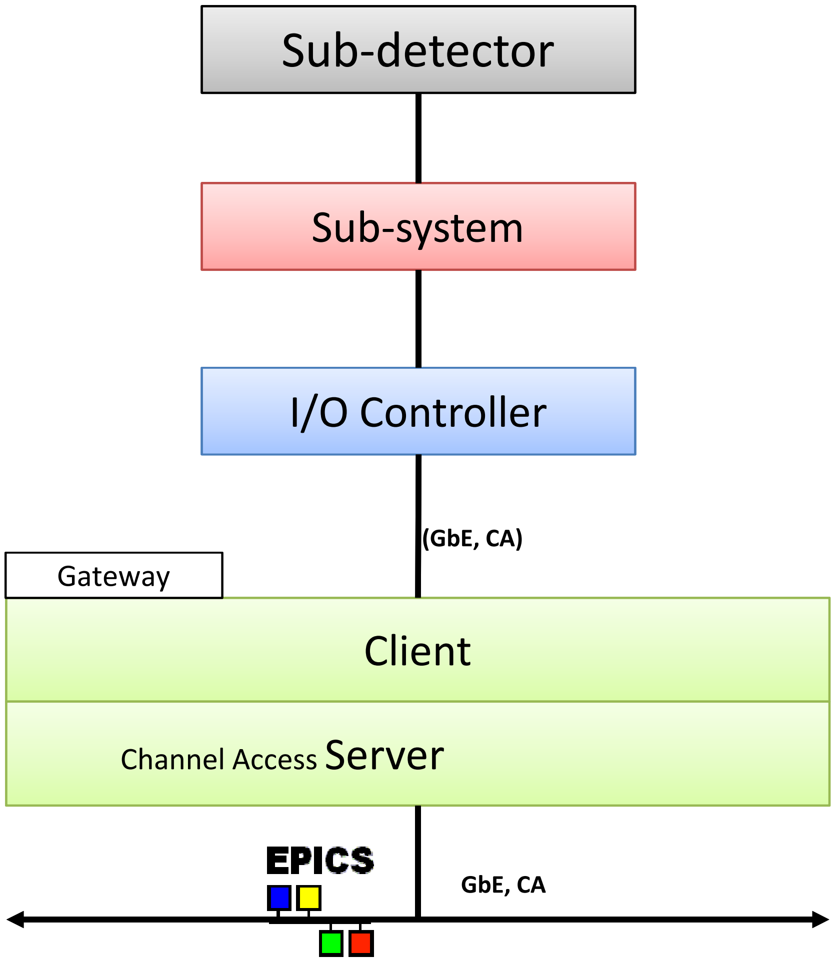
PANDA DCS Architecture - Modularity



Partitioned DCS: pool of Finite State Machine's managed from the supervisory layer by simple commands;

- Eases the commissioning;
- Autonomous operation of each Sub-detector (calibration, physics runs, maintenance);

PANDA DCS Architecture



I/O Controller (IOC): Any device (PC, SBC, COM, micro-controller board, FPGA board etc.) able to manage the I/O of the sub-system;

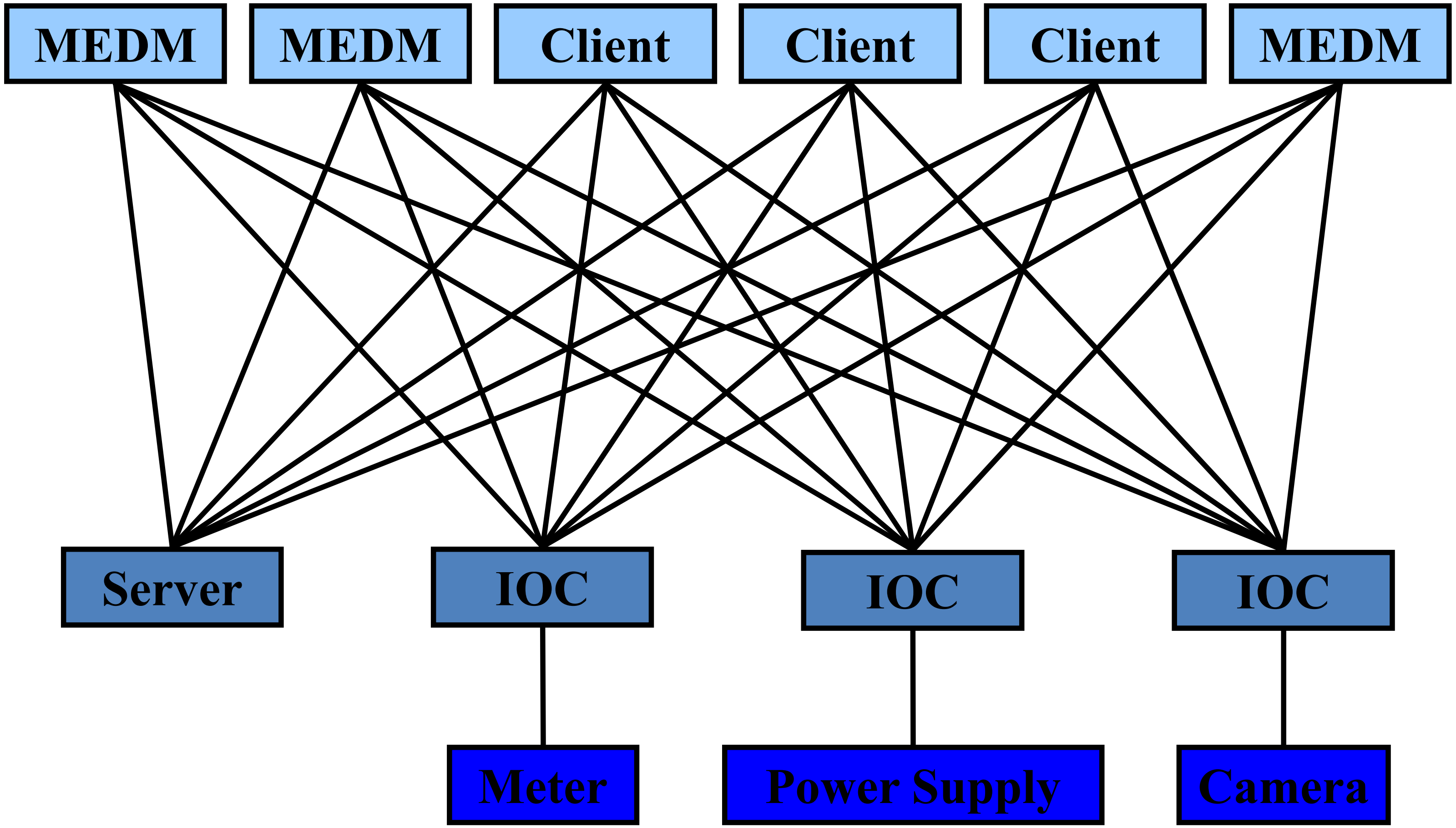
- If National Instruments hw. is used (PC, PXI, CompactRIO, ..) LabView 2009 (or higher) + LabView DSC Module (EPICS I/O Server) are mandatory;

- If > 1 IOC is required we advise the usage of soft IOC running on embedded Linux devices with GbE interface;

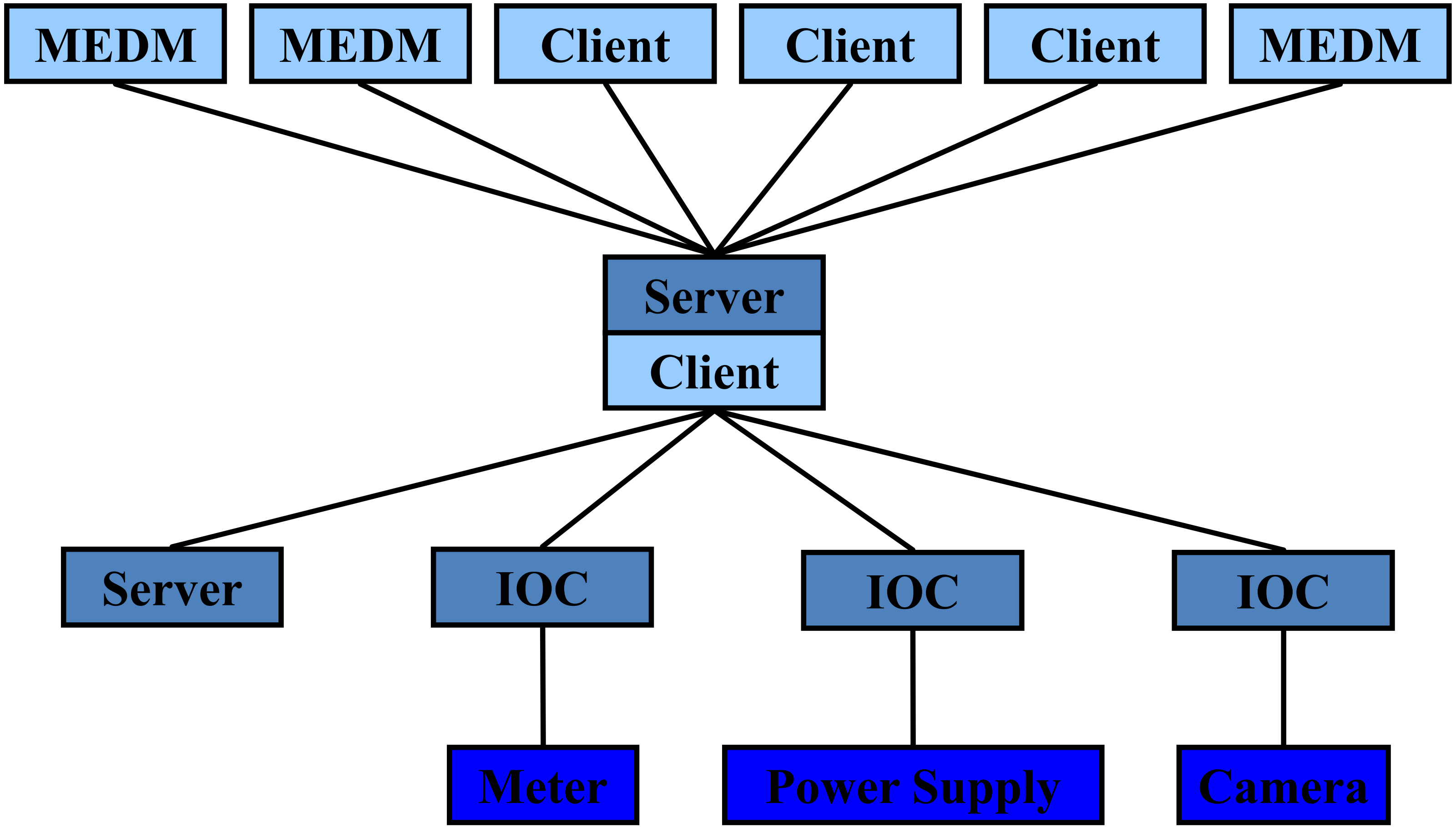
Gateway: Linux server with at least 2 NIC, EPICS 3.14 & Gateway 2.0 extension;

- Reduces the load on critical IOCs;
- Provides convenient access from one subnet to another;
- Provides extensive additional access security.

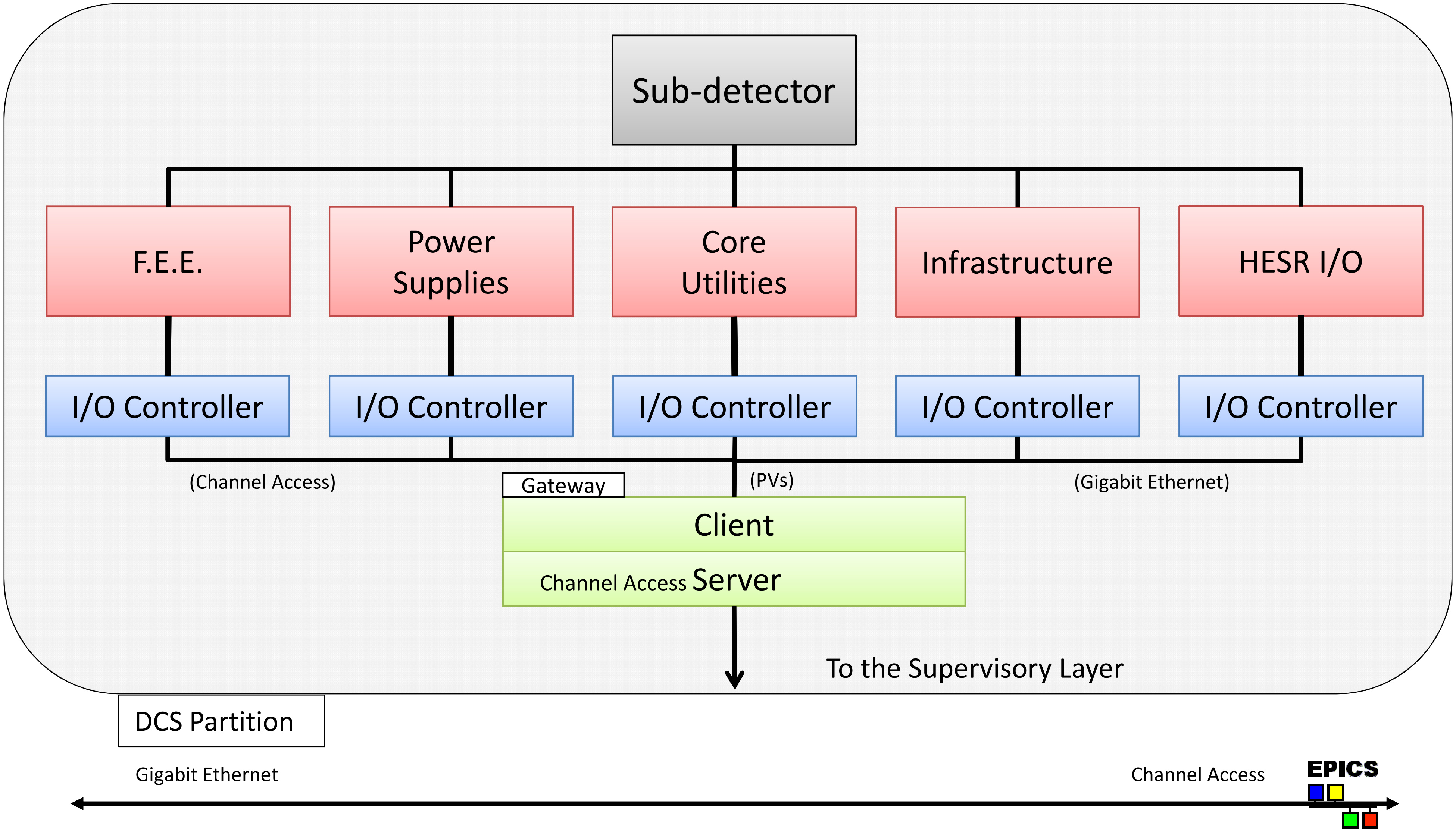
EPICS Overview



Gateway


MEDM
MEDM
Client
Client
Client
MEDM
Server
Client
Server
IOC
IOC
IOC
Meter
Power Supply
Camera

PANDA DCS Architecture - Sub-detector



Embedded ARM IOCs

Well-known ARM based devices: Android Smartphone & Tablet, Apple iPhone & iPad, Windows Phone & Tablet;

Operating systems: Android, Apple iOS, Various Linux Distributions, Windows RT;

ARM Development Boards: ARMv6 -> Raspberry Pi ,
ARMv7 -> Beagle Board, Panda Board

(for a more complete list look at http://en.wikipedia.org/wiki/Comparison_of_single-board_computers)

ARM Linux distributions: Ubuntu, Linaro, Archlinux, Angstrom, Raspbian, ...

Embedded ARM IOCs

ARM: Acorn RISC Machine
RISC: Reduced Instruction Set Computing -> CPU Design based on the insight that simplified instructions can provide higher performance if this simplicity enables much faster execution of each instruction (source Wikipedia)

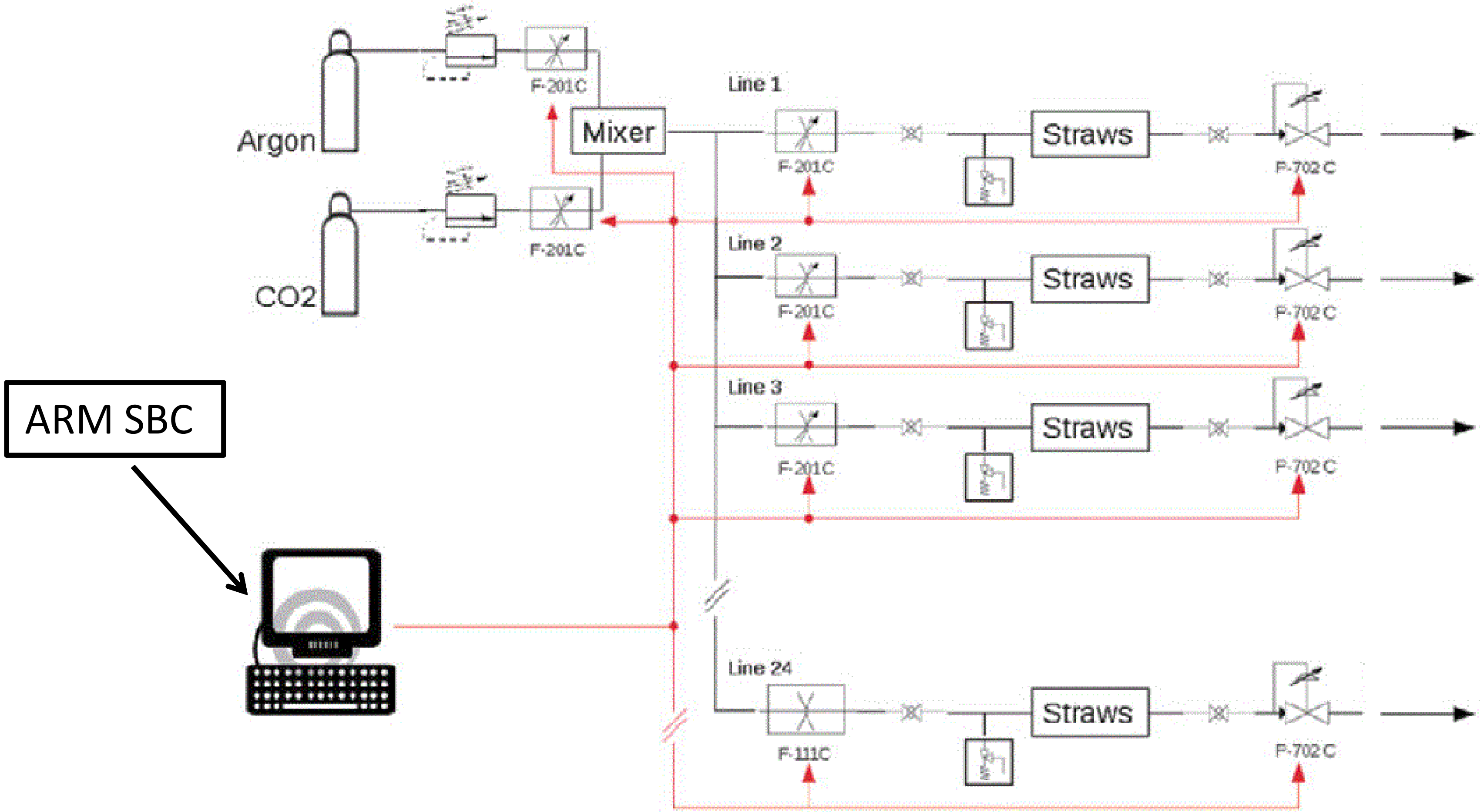
Architecture	Family
ARMv1	ARM1
ARMv2	ARM2, ARM3
ARMv3	ARM6, ARM7
ARMv4	StrongARM, ARM7TDMI, ARM9TDMI
ARMv5	ARM7EJ, ARM9E, ARM10E, XScale
ARMv6	ARM11
ARMv6-M	ARM Cortex-M0, ARM Cortex-M0+, ARM Cortex-M1
ARMv7	ARM Cortex-A5, ARM Cortex-A7, ARM Cortex-A8, ARM Cortex-A9, ARM Cortex-A15, ARM Cortex-R4, ARM Cortex-R5, ARM Cortex-R7
ARMv7-M	ARM Cortex-M3, ARM Cortex-M4
ARMv8-A	ARM Cortex-A53, ARM Cortex-A57

1985

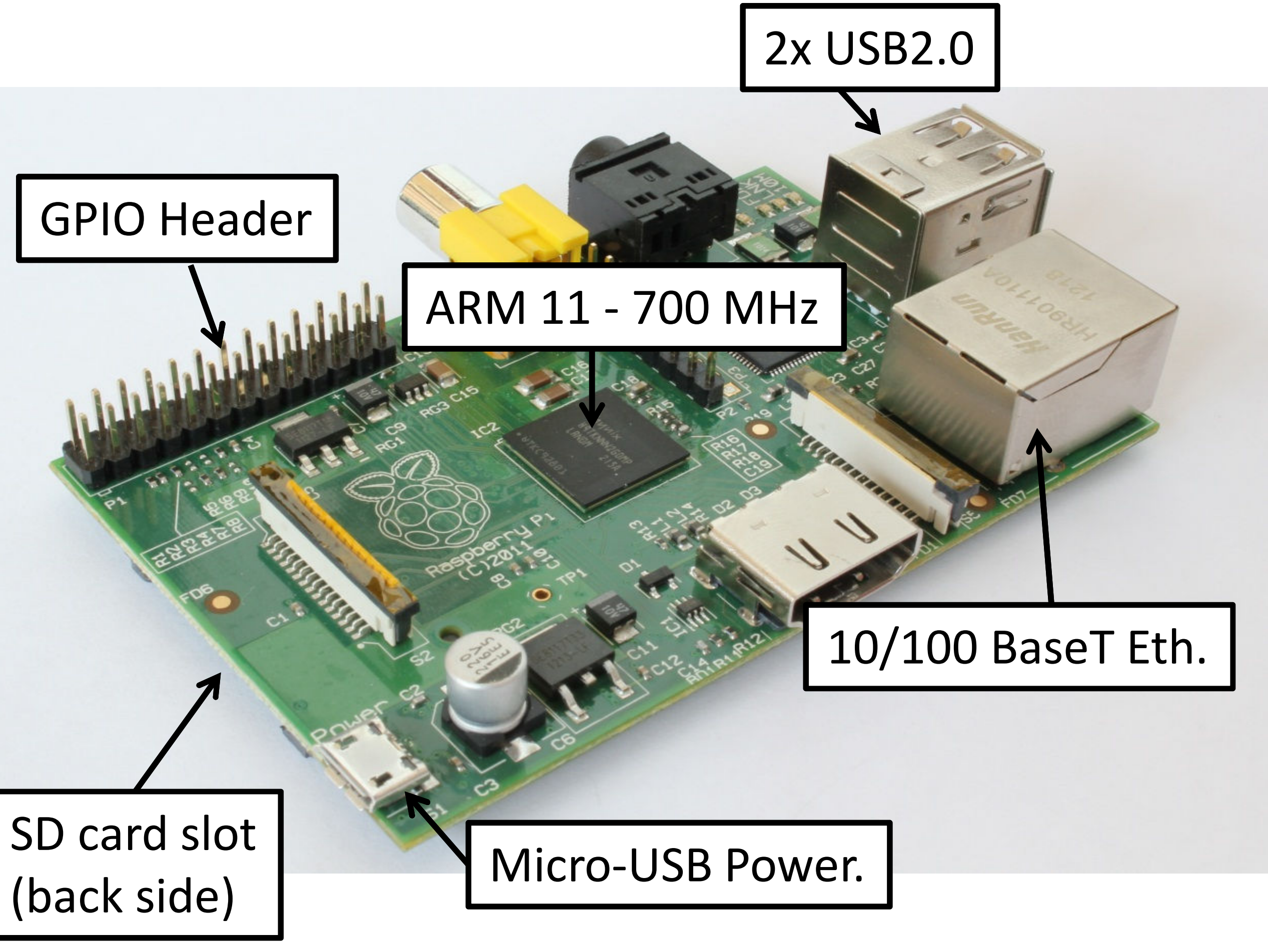
2012

PANDA STT Gas system

Eur. Phys. J. A (2013) 49: 25



Raspberry PI Single Board Computer as I/O Controller for STT Gas System



Price: about 40 euro
Low stocks

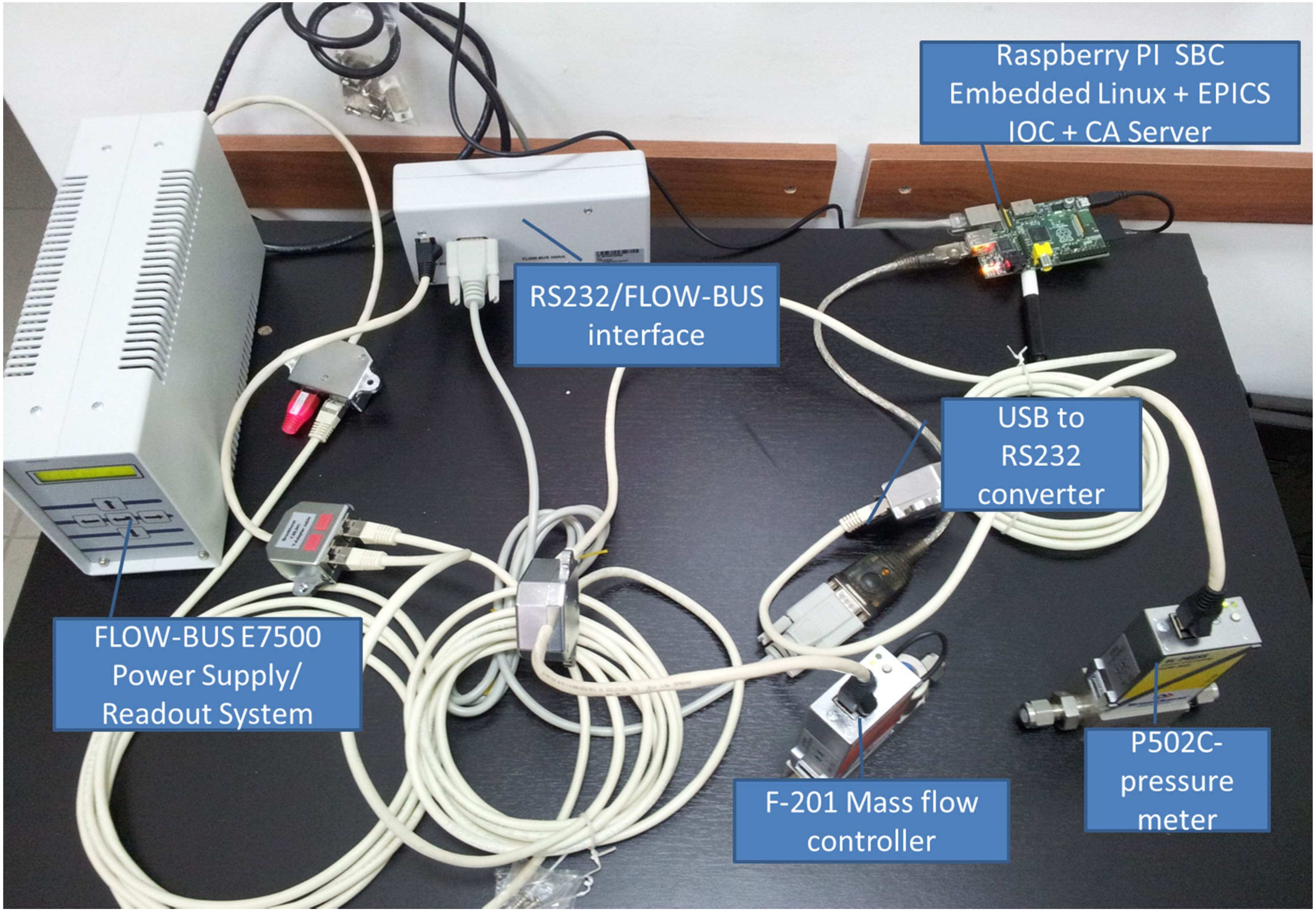
I/O Controller for PANDA STT Gas system

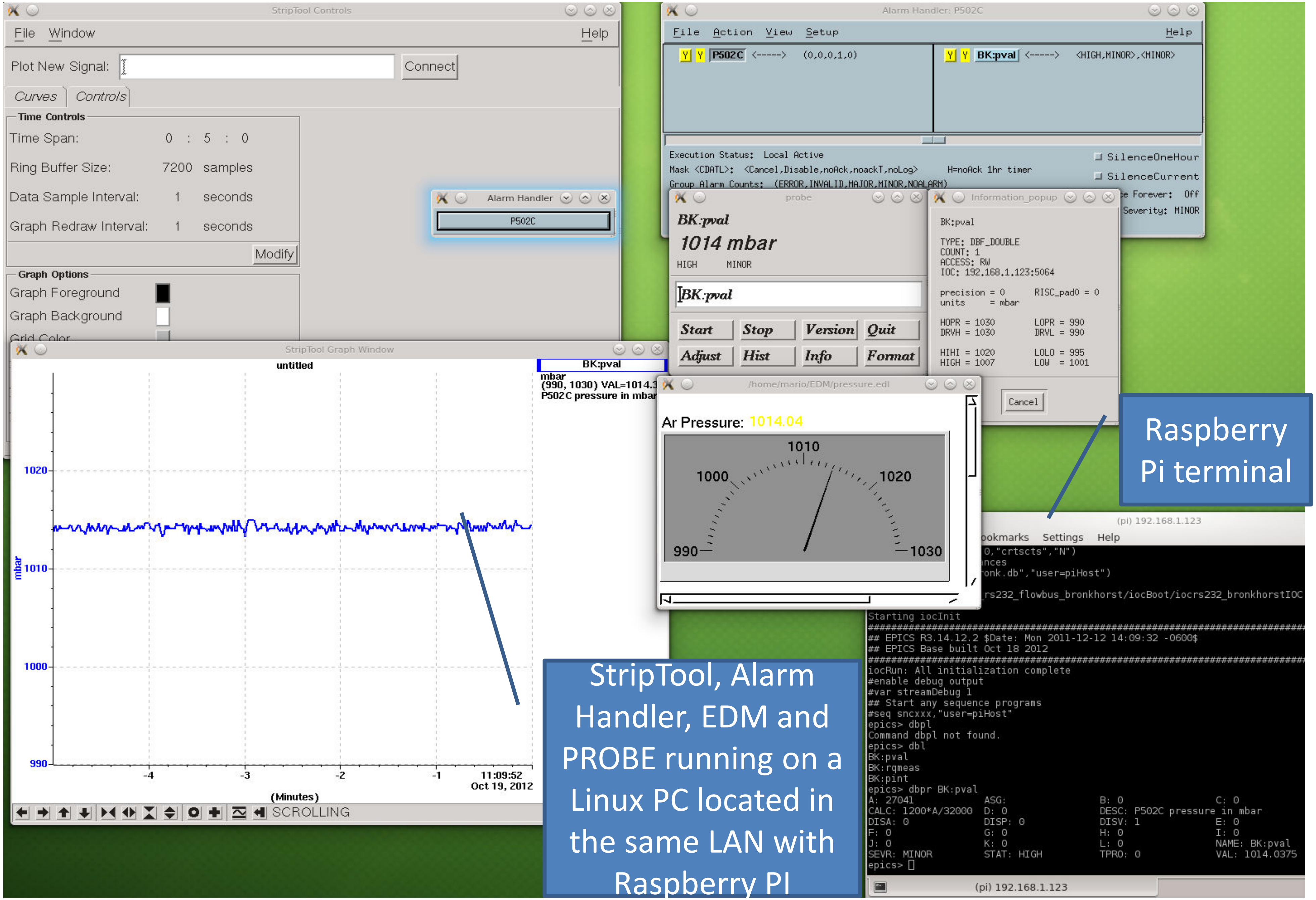
Connected via **RS232 to Bronkhorst FLOWBUS**

Host: Raspberry Pi Model B
SD Card boot:
Raspbian OS (based on **Debian Linux**)

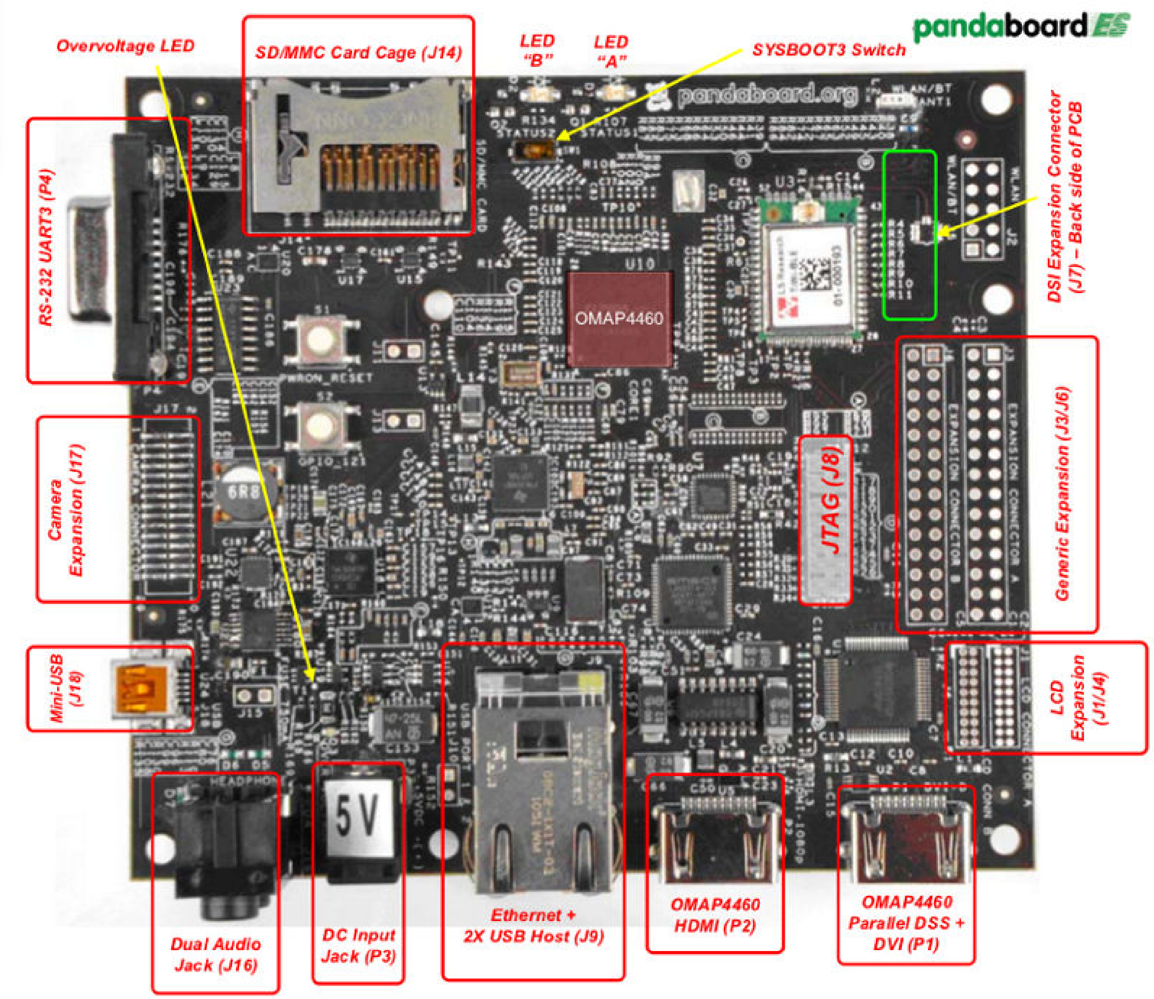
with
Epics base 3.14.12.2

Modules:
AsynDriver 4.2
StreamDevice 2.6
Calc 3.0


Raspberry PI SBC
Embedded Linux + EPICS
IOC + CA Server
RS232/FLOW-BUS
interface
USB to
RS232
converter
FLOW-BUS E7500
Power Supply/
Readout System
F-201 Mass flow
controller
P502C-
pressure
meter


StripTool Controls
Plot New Signal:
Connect
Time Controls
Time Span: 0 : 5 : 0
Ring Buffer Size: 7200 samples
Data Sample Interval: 1 seconds
Graph Redraw Interval: 1 seconds
Alarm Handler: P502C
BK:pval
1014 mbar
Ar Pressure: 1014.04
StripTool Graph Window
Raspberry Pi terminal
StripTool, Alarm Handler, EDM and PROBE running on a Linux PC located in the same LAN with Raspberry PI

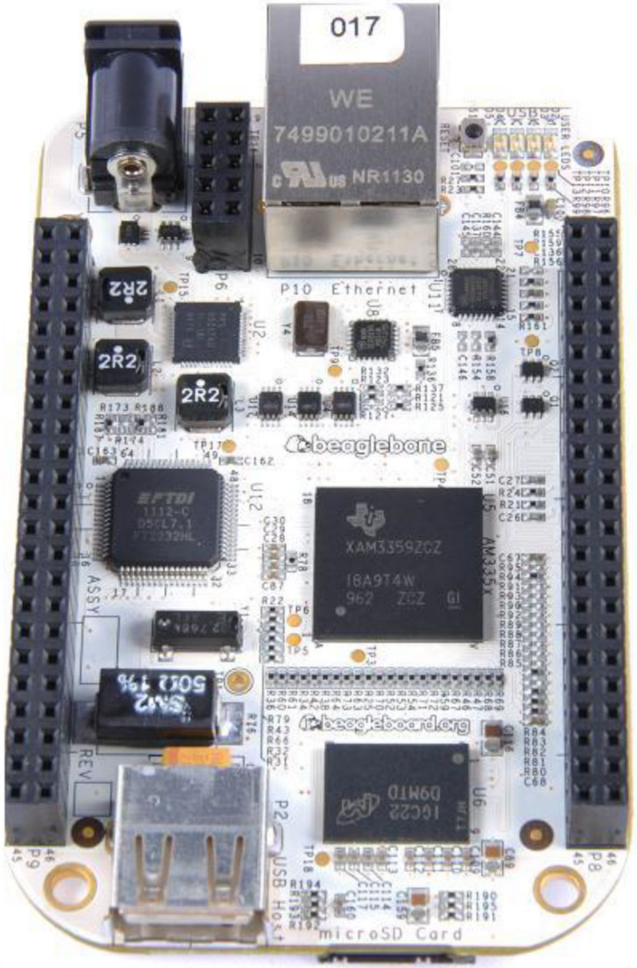
Linux Ready ARM IOC candidate - PandaBoard ES



PandaBoard ES highlights:
- Dual-core ARM® Cortex™-A9 MPCore™ with Symmetric Multiprocessing (SMP) at up to 1.2 GHz each;
- 1 GB low power DDR2 RAM;
- Full size SD/MMC card cage with support for High-Speed & High-Capacity SD cards;
- Onboard 10/100 Ethernet, 802.11 b/g/n Wi-Fi;
- 3x USB 2.0, RS-232, GPIO expansion header;
- Linux **support :** Ubuntu, Linaro

Price: about 170 euro
Large stock

Linux Ready ARM IOC candidate - BeagleBone



BeagleBone highlights:
Processor: AM335x 720MHz ARM Cortex-A8
USB client: power, debug and device
USB host
Ethernet
HDMI
2x 46 pin headers
Software Compatibility
4GB microSD card w/ Angstrom Distribution
Cloud9 IDE on Node.JS w/ BoneScript library

BeagleBone **can be complemented** with cape **plug-in boards** to augment functionality: CANBus Cape, RS232 Cape, RS485 Cape, ProfiBus Cape, etc.

Price: about 75 euro
Large stock

CAN benchmarks on ARM IOC's

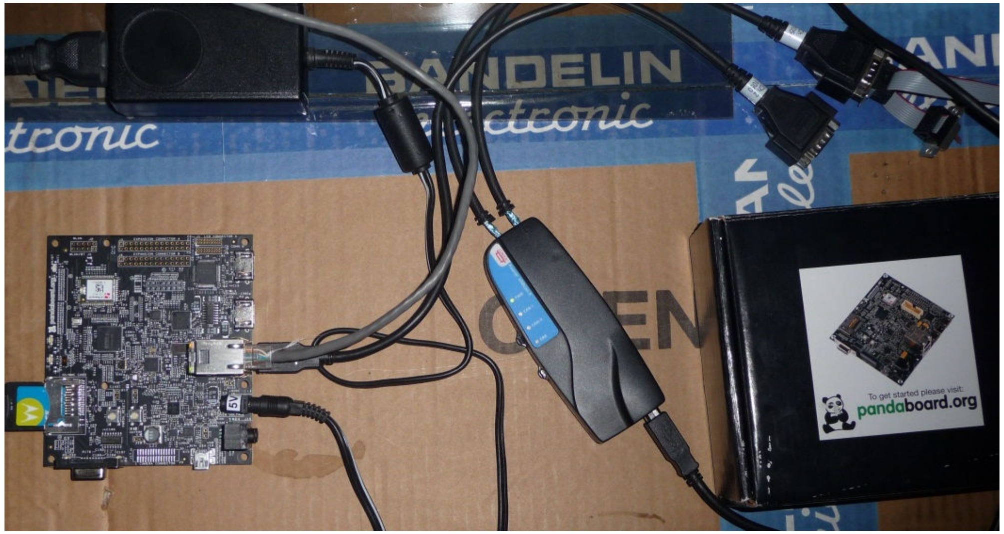
IFIN-HH CAN performance test setup:

- **PandaBoard** ES -Linaro based on Ubuntu 12.04 LTS
- **Raspberry Pi** Model B- Raspbian or Arch Linux
- **BeagleBone** -Arch Linux
- **Kvaser USBcan II HS/HS**, Kvaser Linux Driver (V4.82)
- **NI PXI-8464/2** CAN Bus Interface

IFIN-HH Software development:

- Patch for the Kvaser Linux driver (the driver has no support for ARM architecture on Linux);
- modified CAN Sender/Receiver based on Kvaser code;
- modified CAN Sender/Receiver for PXI-8464 (LabView)

Producer software tools: KVASER CANKing, NI-CAN Bus Monitor

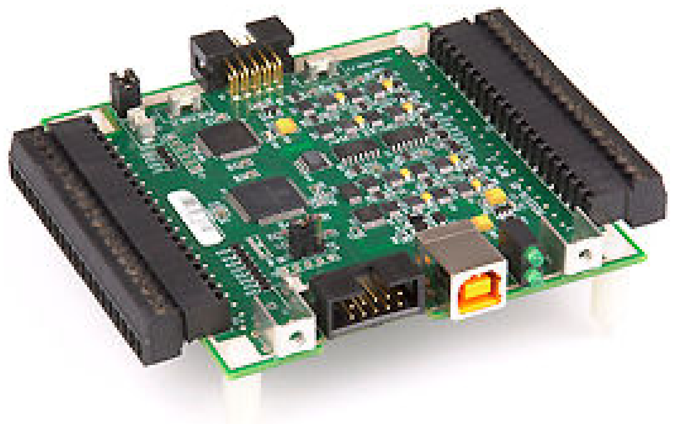


CAN Performance results

Sender	Receiver	Mean Rcv. CAN fr/s	CAN Bus Load (%)
RPi & Kvaser	PXI-8464	3100	45
PandaBoard ES & Kvaser	PXI-8464	5700	82
BeagleBone & Kvaser	PXI-8464	5370	77
Laptop & Kvaser Windows	PXI-8464	5850	84
Laptop & Kvaser Linux	PXI-8464	6050	87
PXI-8464	Laptop & Kvaser	4500	65
PXI-8464	BeagleBone & Kvaser	4400	64
PXI-8464	PandaBoard ES & Kvaser	4350	63
PXI-8464	RPi & Kvaser	3050	44

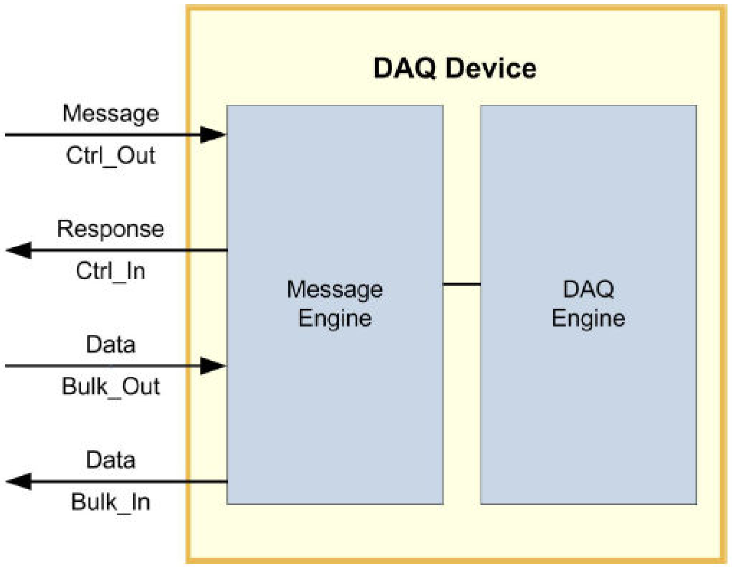
All tests performed with extended CAN frame, Baud Rate 1M.

ARM IOC with USB Multifunction DAQ



USB-7204 from Measurement Computing (MCC)

Key Highlights:
8 analog inputs, up to 50 kS/s sampling, 12 bit resolution, 16 digital I/O, 2 – 12 bit analog outputs



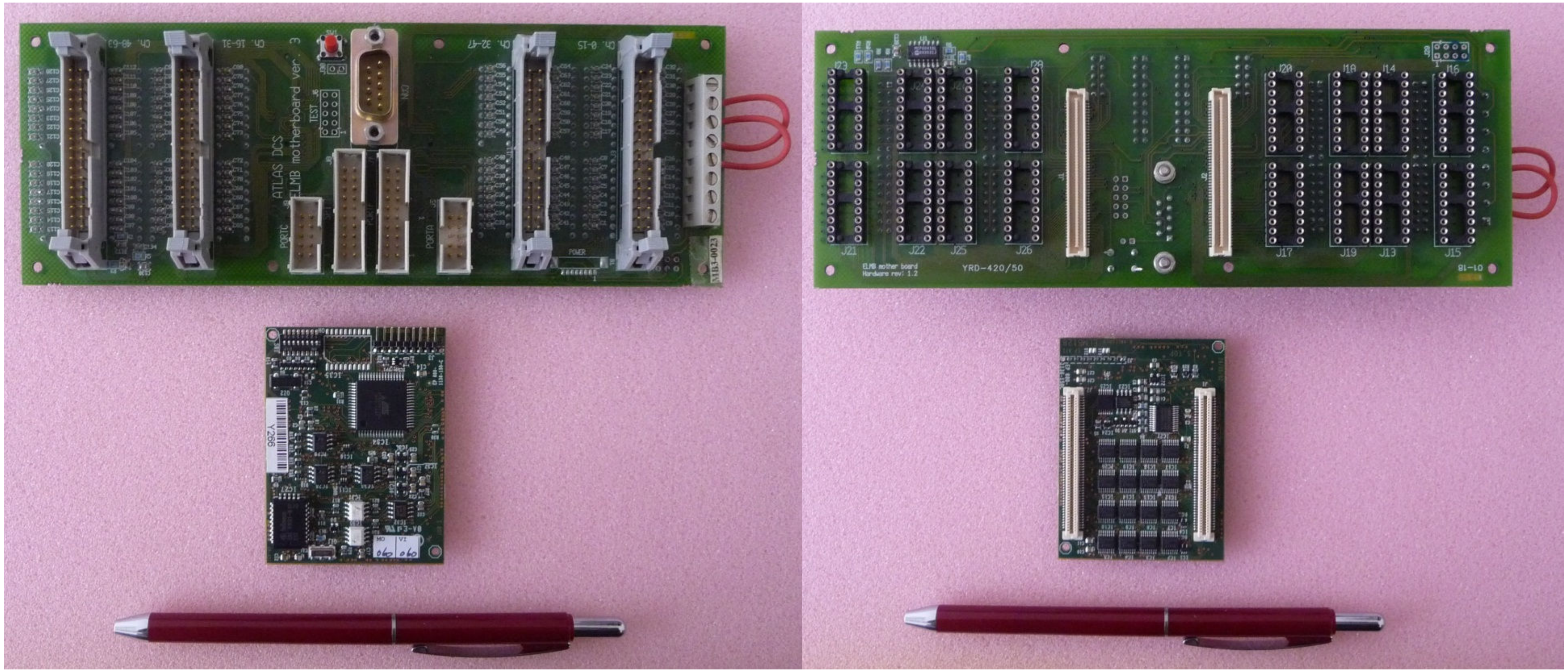
MCC Software support: DAQFlex (open-source driver)

- the communication with the DAQ Engine is made through plain text messages (converted into the message engine);

More details will be given in Matei's talk

Evaluation of ATLAS ELMB128

Embedded Local Monitor Board – developed by CERN, NIKHEF, and PNPI for the ATLAS Experiment



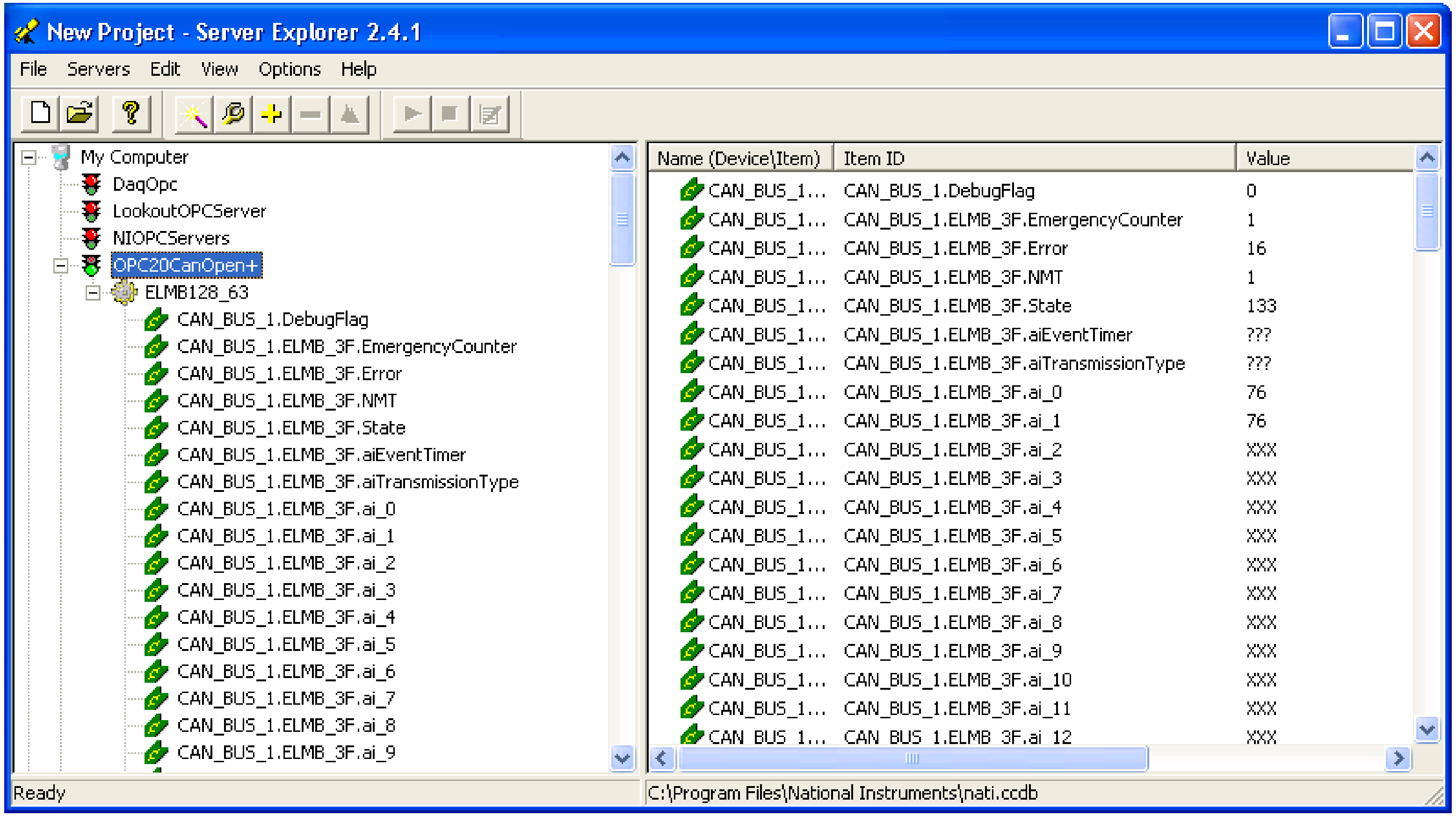
Highlights

Hardware: ATmega128 microcontroller, SAE 81C91 CAN Controller, CS5523 – 16bit differential ADC;
Ports: 4 x 16 differential AI channels, up to 24 bi-directional DIO lines
Qualified for radiation levels from LHC
Used in ATLAS, ALICE, CMS, COMPASS, ….

Evaluation of ATLAS ELMB128

Software support: Henk Boterenbrood (firmware, tools), from NIKHEF, ATLAS DCS (OPC server)
ATLAS implementation: **read/write ELMB via CANOpen OPC server into PVSS**

IFIN-HH setup: ELMB128 + Motherboard, NI PXI-8464 CAN, LabView 2009+EPICS I/O Server



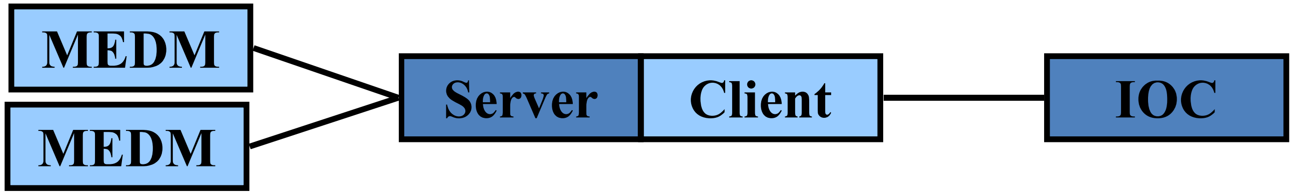
Status: connection between PXI-8464 and ELMB128 established via OPC server ; ELMB read/write access from LabView

If other sub-detectors are interested to implement ELMB128 we can offer support

BACKUP SLIDES

What is the Gateway ?

- Both a Channel Access server and a Channel Access client
  - Clients such as MEDM connect to the server side
  - Client side connects to remote servers such as IOCs



- Allows many clients to access a process variable while making only one connection to the remote server
  - Reduces the load on critical IOCs or other servers
- Provides access from one subnet to another
  - For example, from an office subnet to a machine subnet
- Provides extensive additional access security
  - For example, only read access from offices
- Can provide aliases for process variable names