CMS HCAL

H C A L

Proposal for the rad-hard Monitoring Unit Chipset development

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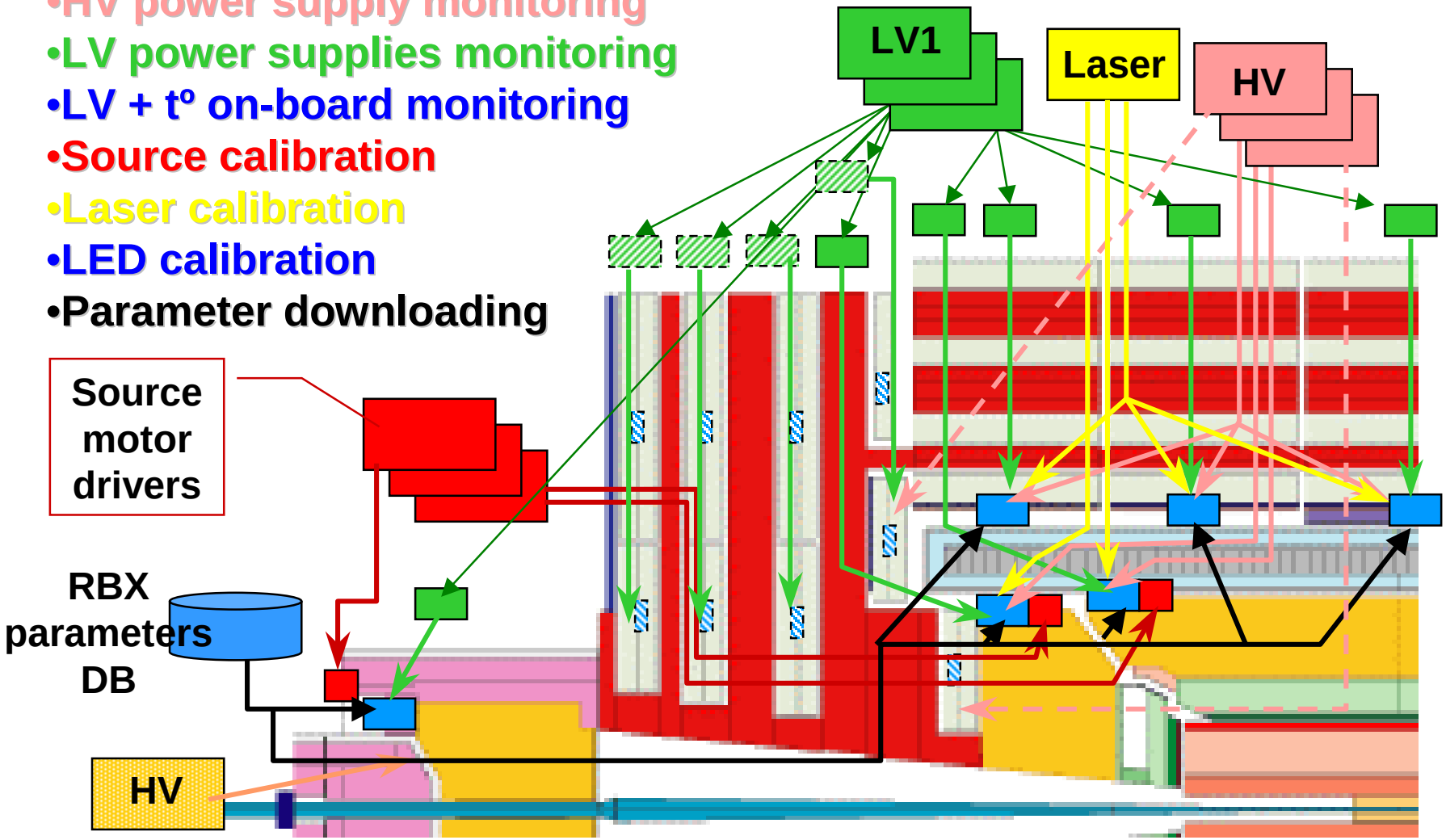
FNAL/JINR

HCAL Monitoring

- HV power supply monitoring
- LV power supplies monitoring
- LV + tº on-board monitoring
- Source calibration
- Laser calibration
- LED calibration
- Parameter downloading



Requirements to MU

1. Radiation levels (with safety factor 3)
   - neutrons > 100 keV: 1.3×10^{11} n/cm^2
   - ionizing dose: 330 Rads
2. Not sensitive to SEU
   - No latch-up
   - No need to reload or reboot
3. Analog input number <=24 (for ME1/1)
4. Moderate accuracy (~1% => 8 bit ADC)
5. Up to 24 digital inputs/outputs (for ME1/1)
6. Simple external protocol
7. Interface to the internal RBX serial bus (downloading of less than 128 bytes)
8. Low transmission rate (4800 Bauds is well enough)

Fieldbus choise

RS485

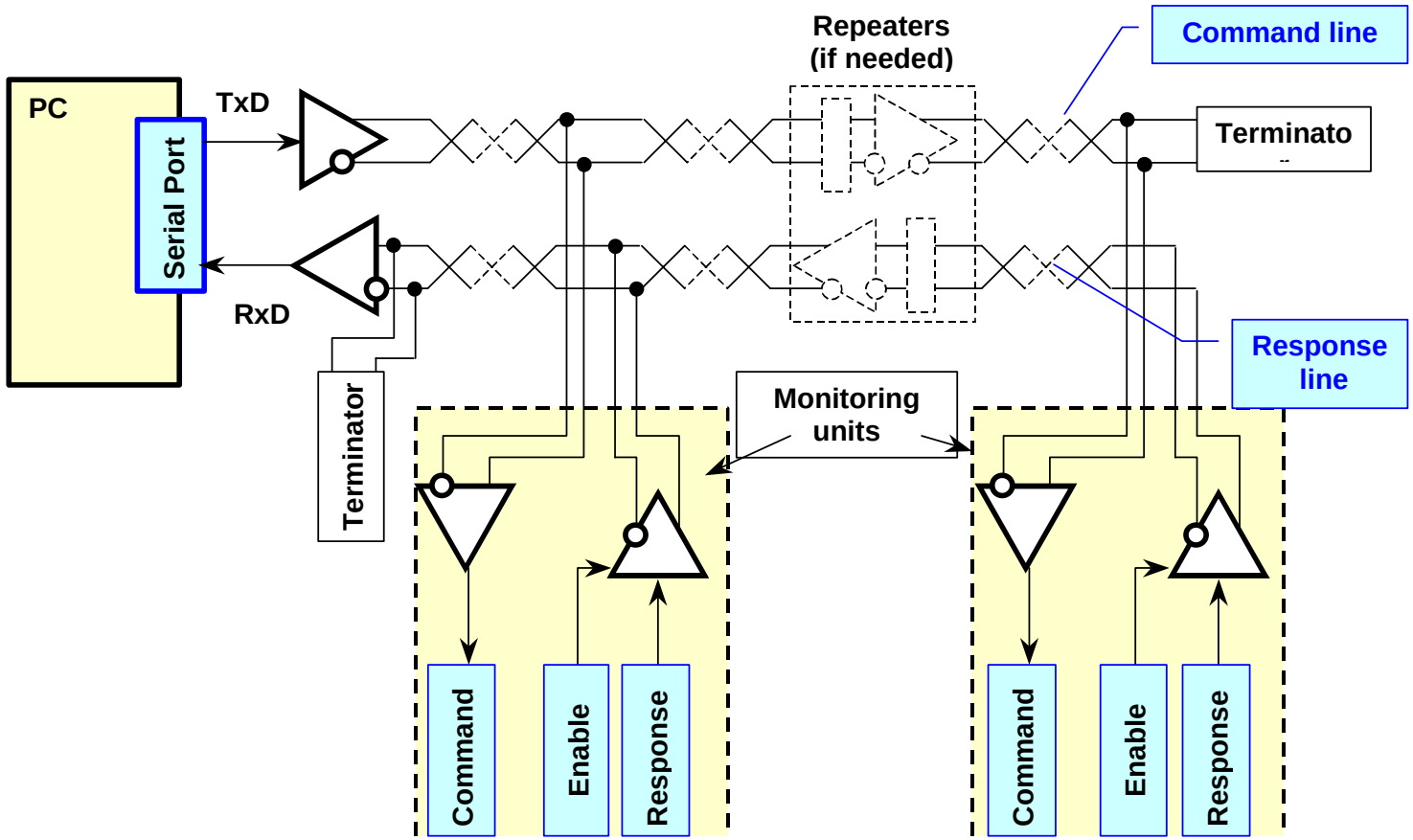
- The simplest one
- Any configuration
- Widely used in the industry (a lot of interface models at the market)
- Uses operating system middleware, needs Dim
- Cheap
- Exists in the HCAL
- Is not the CERN-recommended one

CAN-bus

- Not so simple, for debugging special equipment is needed
- Daisy chain
- Supported by CERN (NI PCI interface recommended)
- The OPC server exists for NI PCI card
- Not so cheap
- Could be used with ELMB
- Is the CERN-recommended fieldbus (is CAN-bus discontinued?, replaced with TCP/IP?)

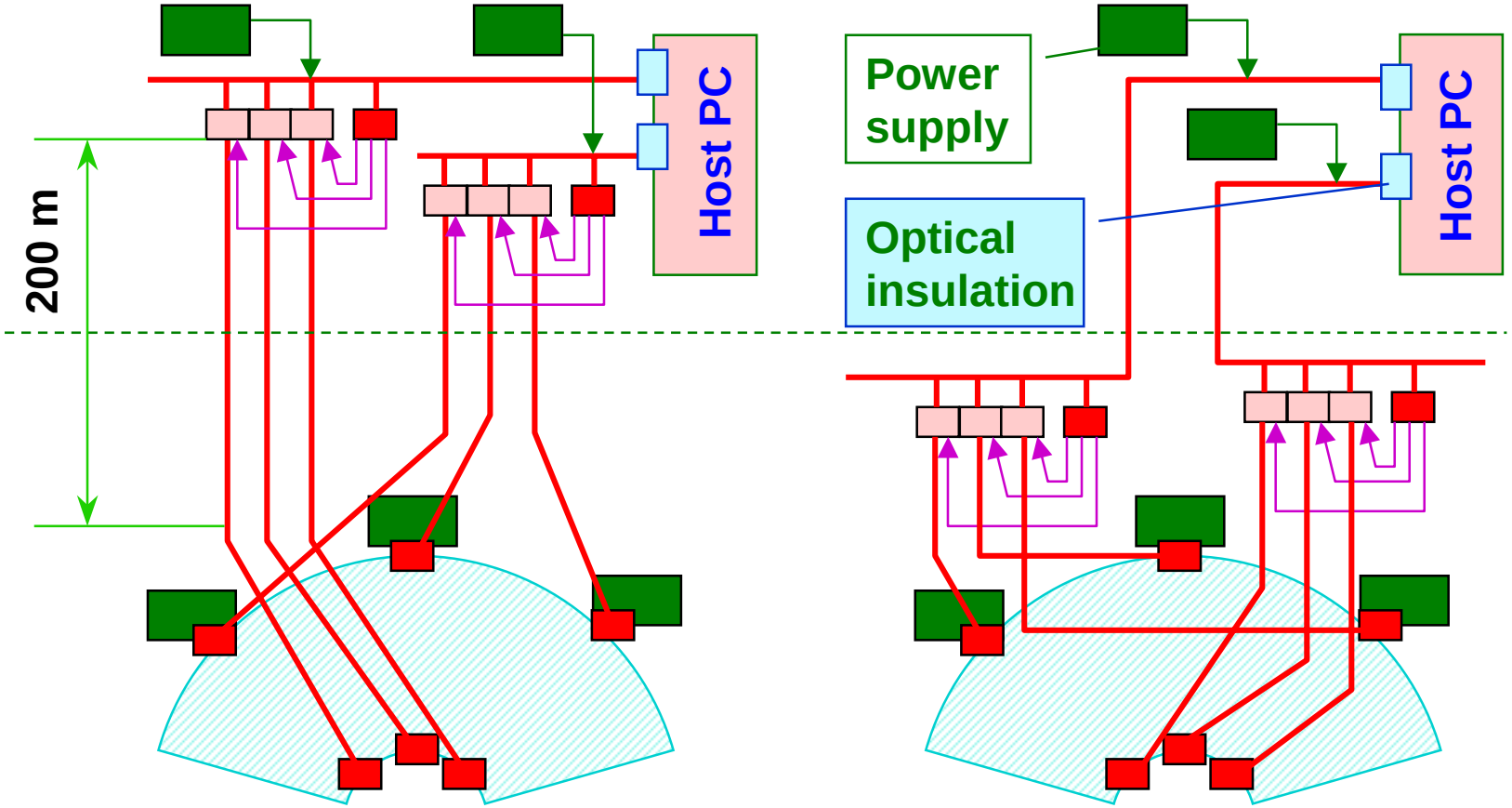
Configuration of RS485

Full-duplex RS-485 Single-Master Four Wire Mulpoint (Multidrop) Configuration



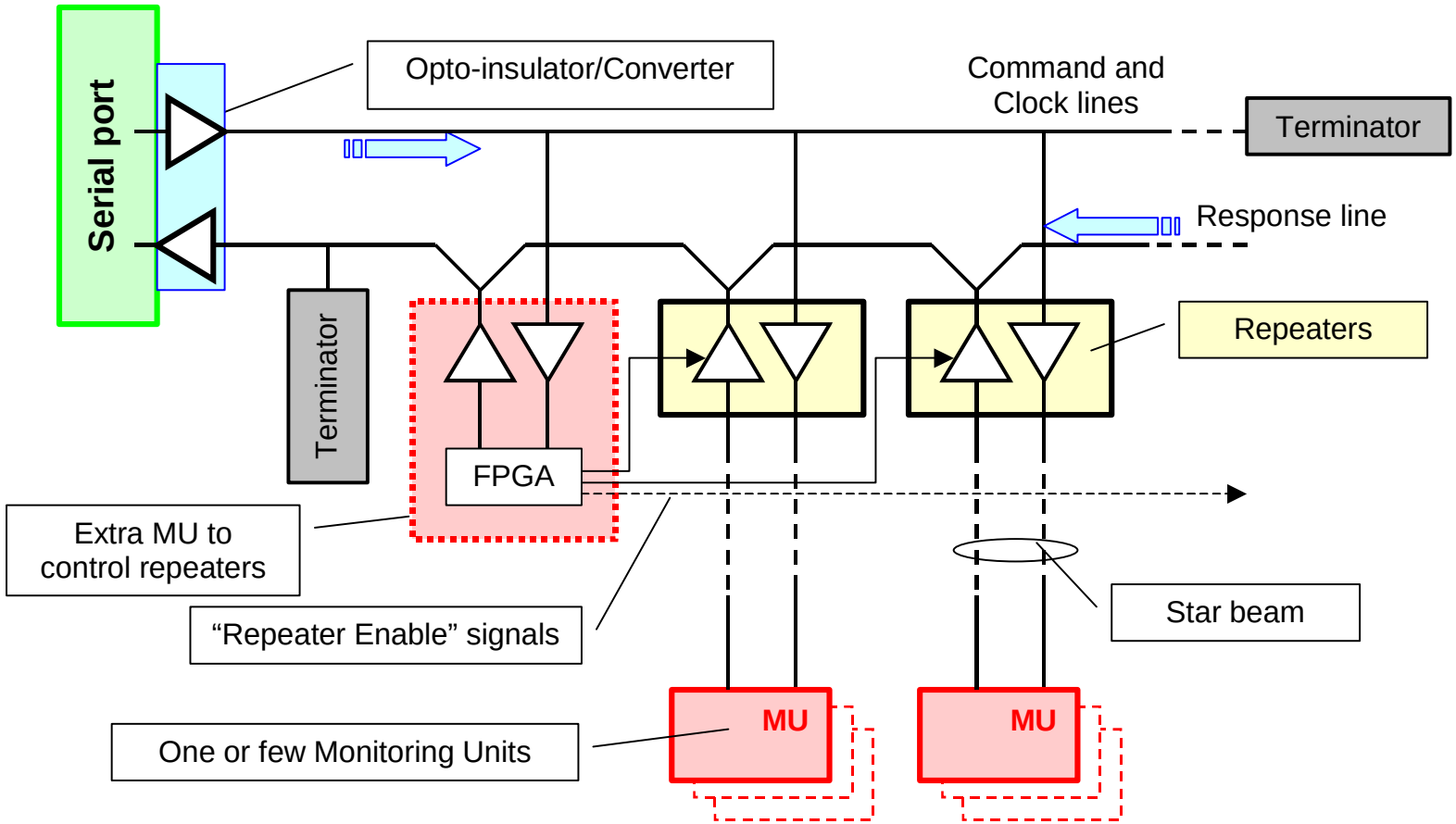
Star-type architecture (I)

Possible communication line architectures

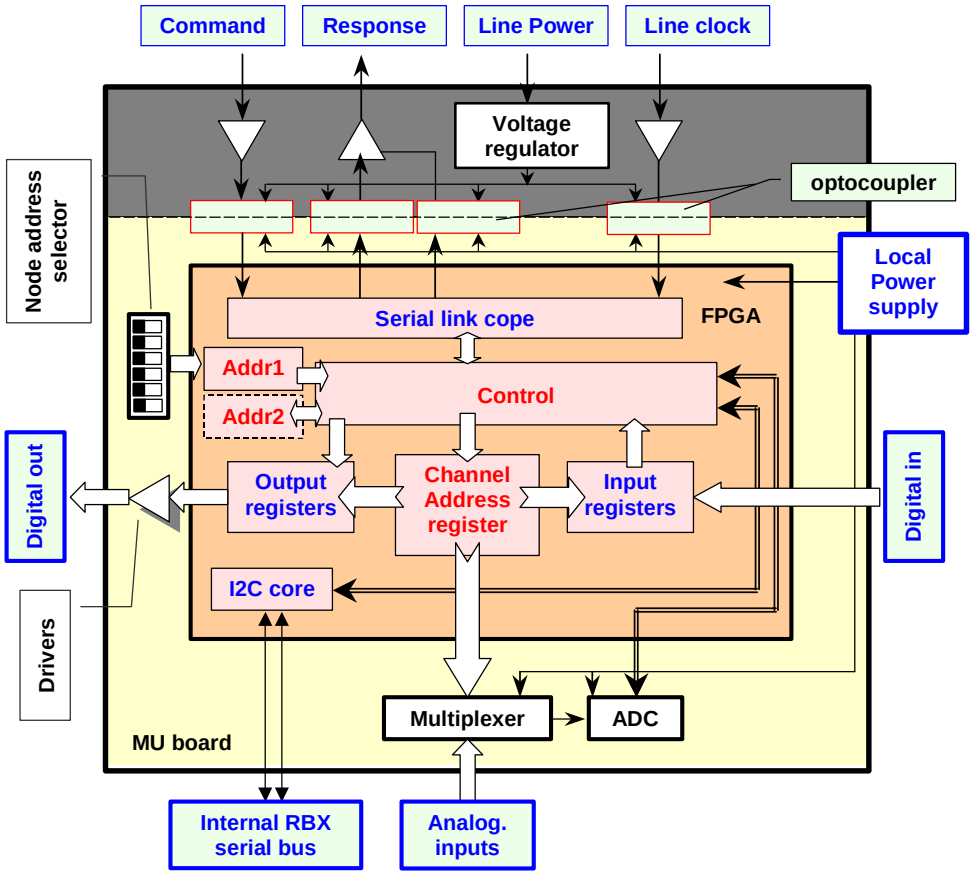


Star-type architecture (II)

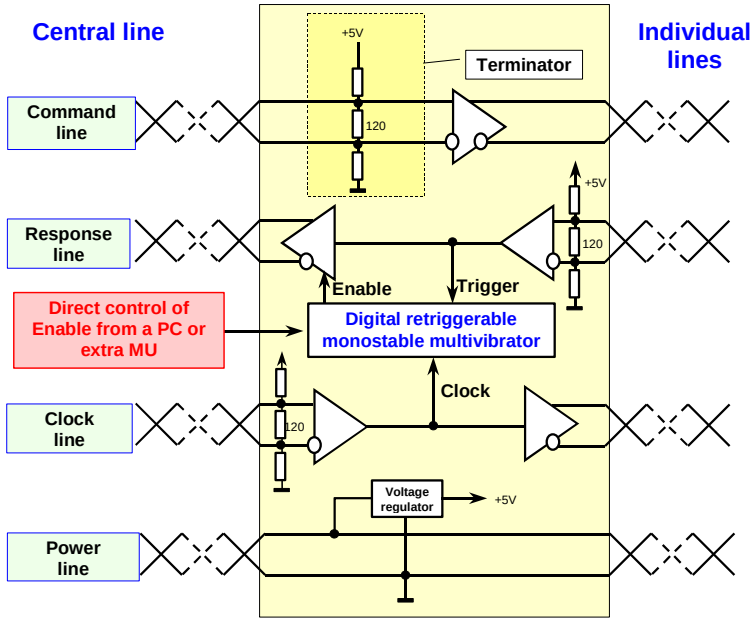
Possible router scheme



MU and Repeater



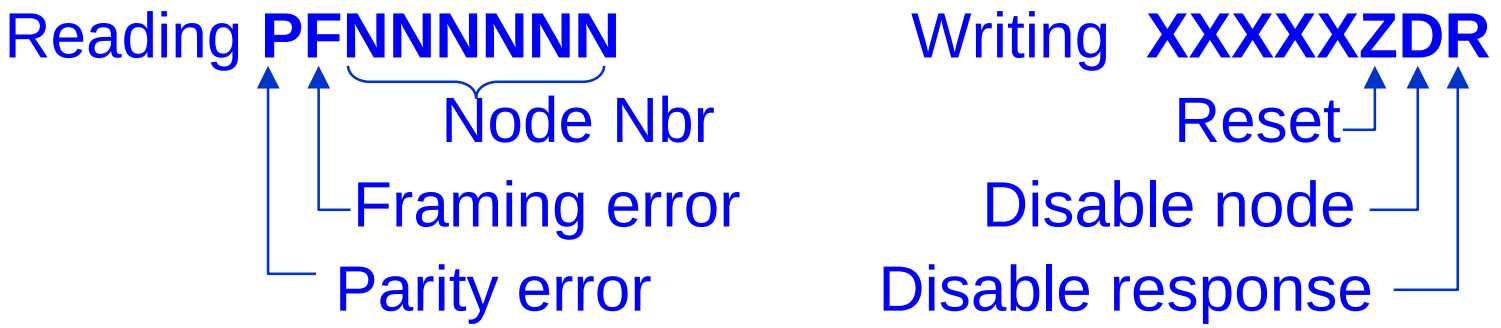
Monitoring Unit



Repeater (Router)

MU internal addresses

- Addresses **0-31** - analogous signal multiplexer with ADC (reading only).
- Addresses **32-47** - digital I/O registers (read/write).
- Addresses **48-61-** I2C communication core.
- Address **62** - the group number register (read/write).
- Address **63** - the status byte of MU. Writing to or reading from this byte **resets error bits.**



Communication protocol

- Each byte transmitted in both CL or RL should have a parity check. Kind of parity Odd or Even should be fixed later.
- The commands received by nodes with parity of framing errors should be ignored by the node.
- The operations with node responses received by PC with errors should be repeated.
- The information read-out is performed by the permanent polling.
- The PC sends commands to all MUs in parallel.
- The command XXYYYYYY contains the command code itself (XX- 2 bits) and the operand (YYYYYY - 6 bits). The operand could be a number of the selected node or the content of the channel selection register.

Communication prot. (II)

XX=00 writes the operand content YYYYYY to the channel selection register. Operation is **common** for all nodes. No node response is needed.

XX=01 requests the **read-out** of content of the **selected** input channel (ADC, input registers, I2C registers, status). YYYYYY contains the number of the selected node.

If the node response is enabled then the selected node responds with 3-byte message containing

1. Node number,
2. Node Status byte,
3. Selected channel content.

This operation uses **individual** node addresses only.

Communication prot. (III)

XX=10 is used to write **single** byte of information to the node. Both individual node numbers or group numbers could be used. The operand YYYYYY contains the **node or group number**.

The **second** byte of message contains a **byte of information** to write to the FPGA **register** selected by the **previous command** with XX=00.

In case of **individual addressing** and if the node response is enabled then the selected node responds with the 2-byte message containing

1. Node number,
2. Node status byte.

If received command or data byte contain a **parity error** this information is **not transferred** to the corresponding register, but the **response** message is **always sent**.

Communication prot. (IV)

XX=11 is used to send an array of bytes. The operand YYYYYY contains an address of the **destination node** or group.

Second byte of the command contains the **length** of the array.

The rest of the command is the data array.

In case of the **individual** addressing and if the node response is enabled then the node **responds** with the 2-byte message containing

- Node number,
- Node status byte.

Signal "BREAK" resets and disables all nodes

MU bus addresses

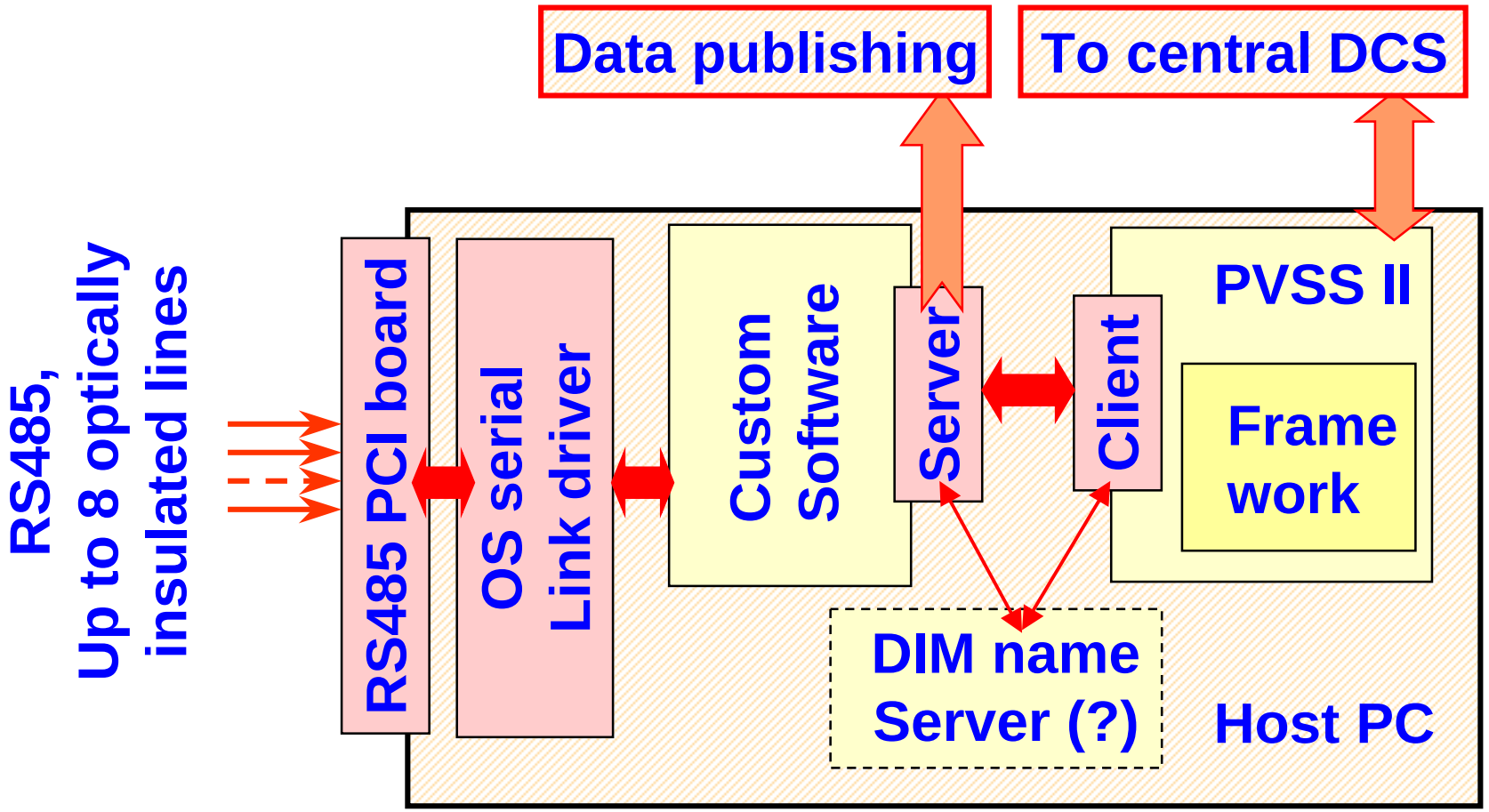
The addresses 0 and 63 are **reserved** for tests and debugging.

Address number **0 does not select** any MU and address number **63 selects all** boards for write-type operations.

Numbers from 1 to 36 - individual nodes in one branch.

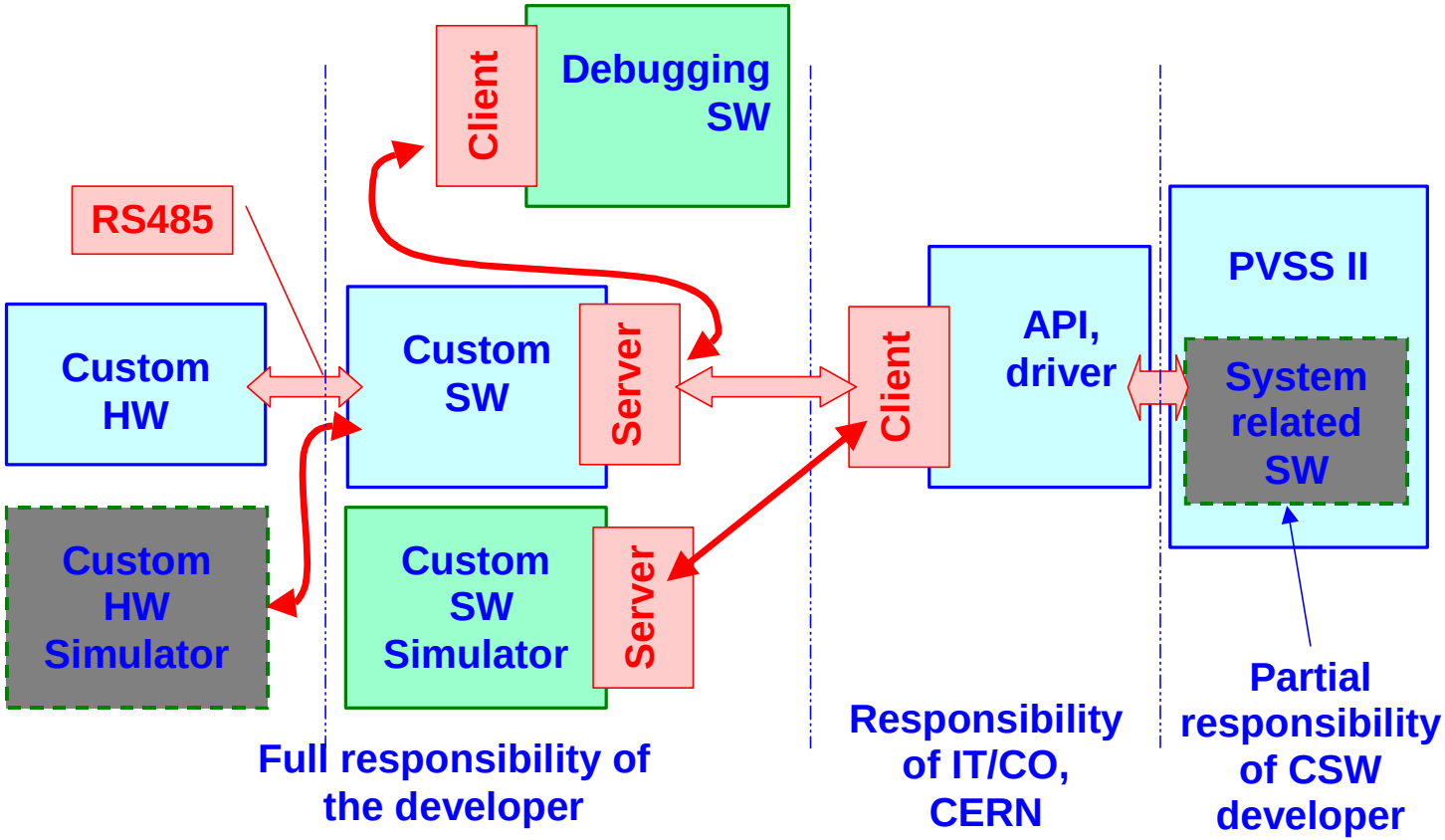
Numbers 37-62 used for groups

System structure



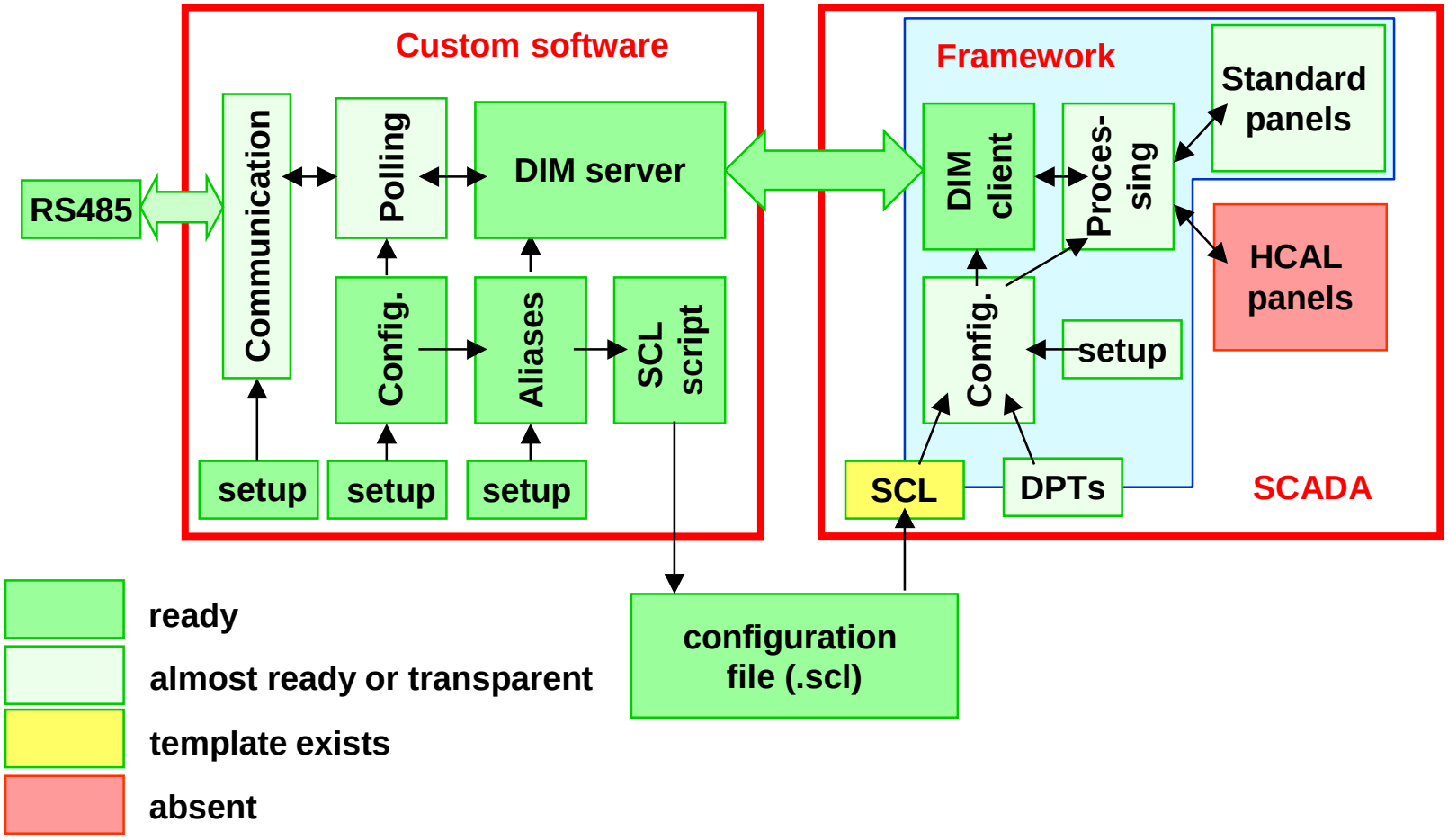
Software structure

Used software architecture

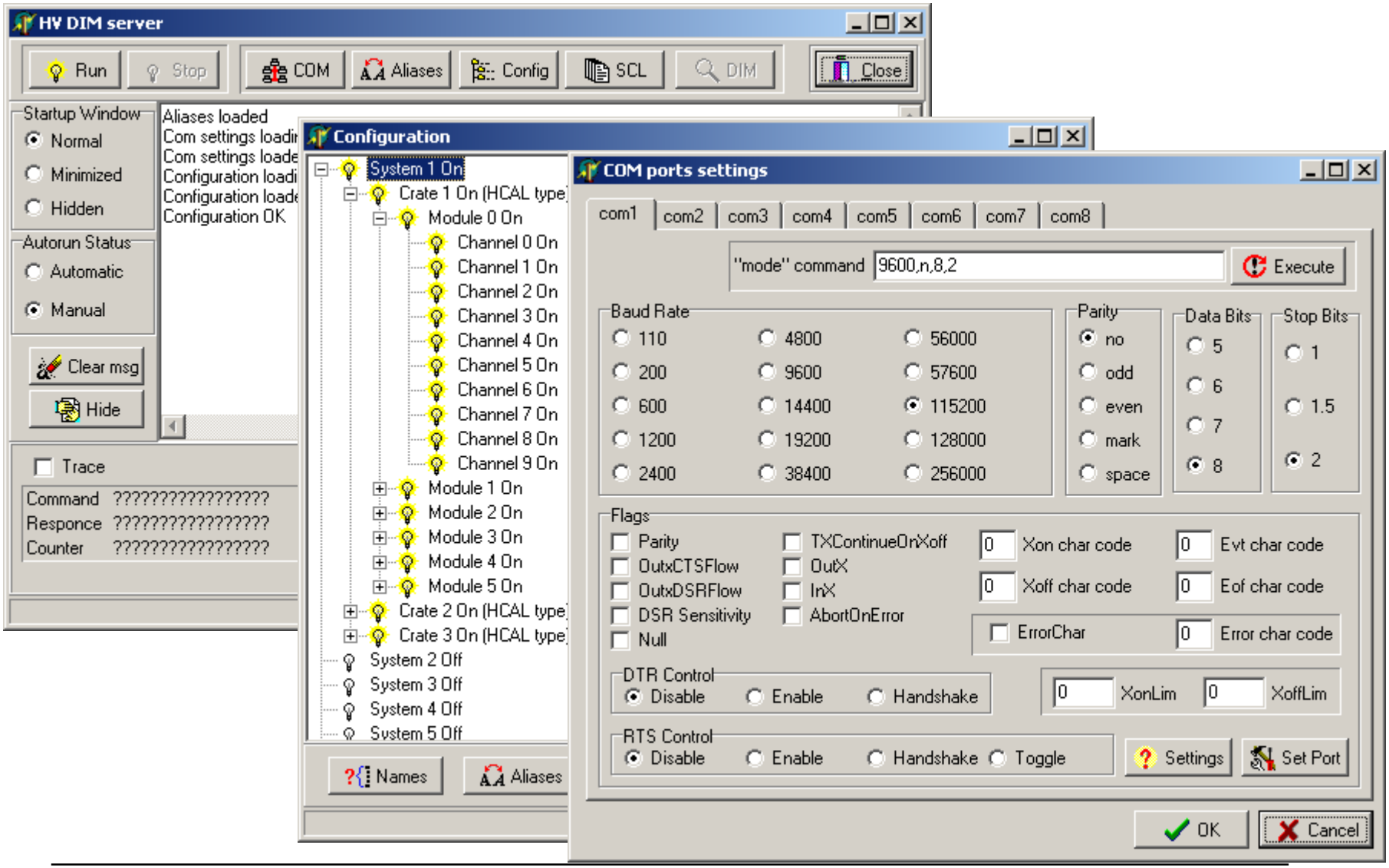


HV system SW structure

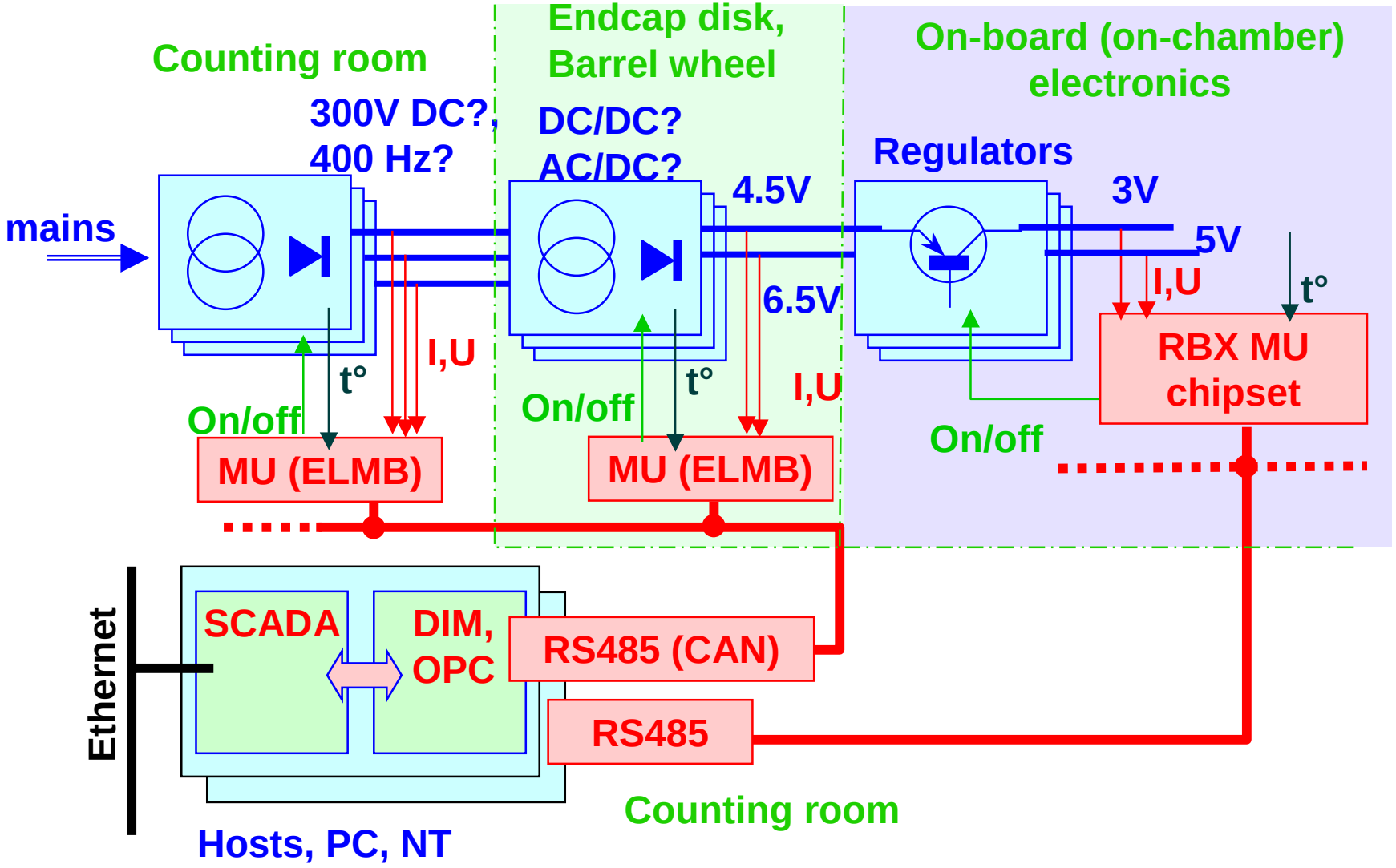
80% could be used for RS485 system



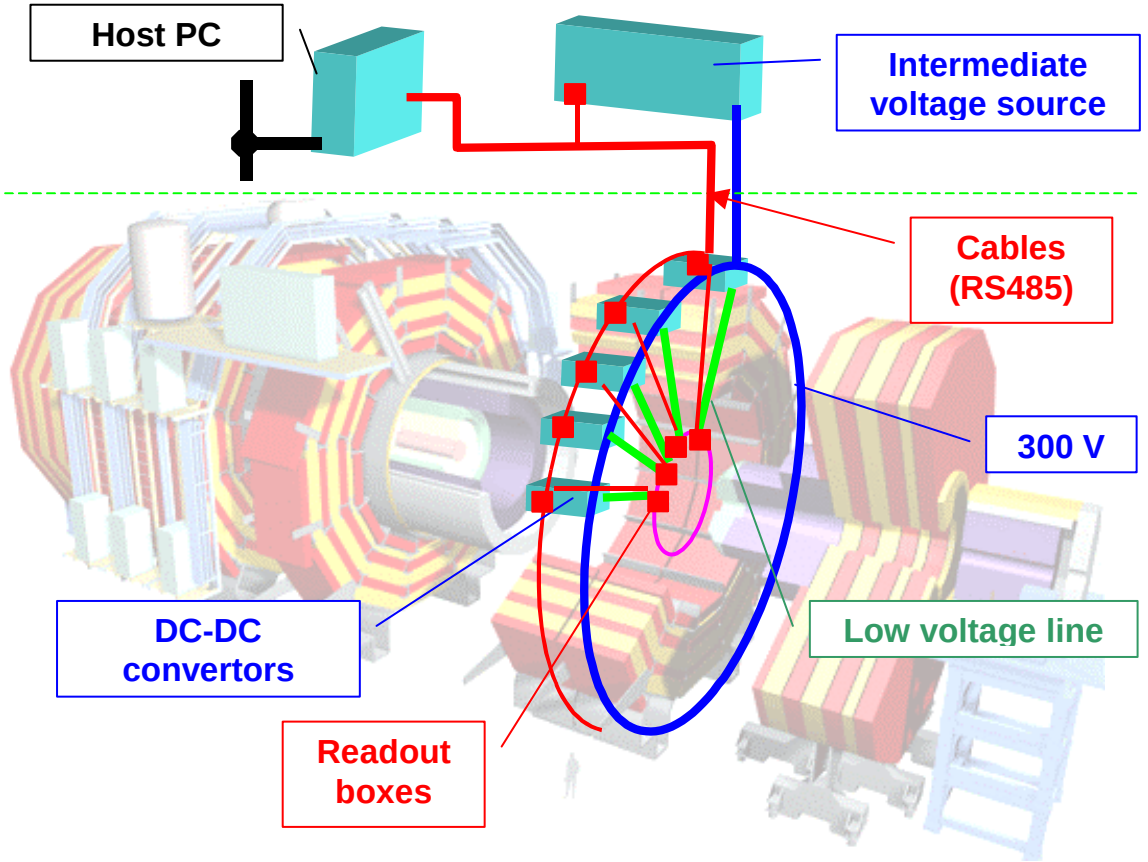
HV Custom software



Low Voltage control system(I)



Low Voltage control system(II)



Power supply monitoring

RS485-based MU

- This standard exists in HCAL
- Not sensitive to SEU
- Any connection architecture
- Maintenance (like other our equipment) is our problem

ELMB

- No CAN-bus yet in HCAL
- Still sensitive to SEU
- Daisy chain
- ELMB itself be maintained by CERN