GAN: remote operation of accelerator diagnosis systems (with emphasis on hardware devices)

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ABSTRACT

Driven by international collaborations, accelerator control hardware is installed in places where the expert himself is not present. The challenge is to operate this hardware reliably. The expert must be replaced by communication methods, and the hardware itself must be prepared to enable commissioning and service without the expert on the spot. This paper explains some topics for this kind of operation.

GAN CHALLENGES FOR HARDWARE REMOTE SERVICE

For commissioning and troubleshooting, a hardware expert normally has to be directly in the place where his component is located. This is necessary because he has to …

• reboot the system, monitor error messages during the reboot process while remote access is not yet running
• change software, CPU settings (e.g. IP address) and FPGA configurations
• change jumper settings
• calibrate offsets or amplification factors
• do oscilloscope measurements: at inputs and outputs, sometimes at internal test points
• check temperature and operating voltages
• replace hardware components
• analyze electromagnetic interference from / to other devices
• Look, feel and listen: correct cable type? Correct cabling? Fan running? Dust? Vibrations? LEDs on front panel flickering or displaying a certain state?
• These actions, however, are not possible if the expert is not on the spot. So the hardware must be prepared to permit most of these actions by remote access or make them dispensable.

HARDWARE COMPONENTS

If the device needs trimming or configuration, this should be possible remotely:

• Use remote controllable elements for trimming (avoid mechanical potentiometers)
• Replace jumpers by electronic switches
• Implement selftest if possible

REMOTE SOFTWARE AND FPGA CONFIGURATION UPGRADES

Software and FPGA changes need local access for many devices, e.g. by a local programming or configuration connector. This can be done by local staff in many cases. But a remote possibility for programming and/or configuration is preferable. But in this case, accessibility is an important topic. If the expert accidentally changes the kernel functionality, it can easily happen that he loses access to the system, e.g. if he introduces a bug into the signal chain which gives him the remote access. One way out is to ask the local staff for help. But there are other ways to avoid this:

• Clear separation between functionality for the remote communication and programming and configuration (not remotely alterable) on one hand and user functionality (remotely alterable) on the other hand
• Mechanism to fall back to accessible state in case of trouble: if the system is rebooted after a change and it is not validated as „good“ by the specialist during a certain time, it should fall back automatically to a defined software state to guarantee accessibility – see comparable Microsoft feature after changing the computer display resolution
• Other methods to guarantee accessibility?
REMOTE: CPU RESET, POWER ON / OFF, SERIAL MONITOR
- Extra web server which is able to reset the CPU and hardware and/or to switch the crate power on and off
- This web server should provide a serial connection to monitor the CPU startup process before the CPU can communicate over the network – only applicable to CPUs with serial monitor interface.

INTERNAL AND EXTERNAL STATUS
Implement remote check of:
- Temperature
- For special cases: noise, vibrations (use microphone)
- Supply voltage (absolute value, ripple)
- Supply current
- Presence and structure of input signals
- External clock (frequency?)
- External triggers (rep. Rate?)
Important internal signals:
- Internal clock running
- Others, depending on system

INTERNAL DATA LOGGING
- Log commands from and data to the control system including timestamps
- Log all(?) input and output signals (analogue and digital)
- If possible, log backplane and bus signals (VME, CAN)
- If possible, use an extra analyzer FPGA (with enough memory) for analysis and combination of inputs, outputs, commands, data
- Memory contents must not be erased by reboot!

POST MORTEM RECORDER
- If applicable, implement a circular buffer recording relevant data which is stopped when beam is lost to allow diagnosis about beamloss reasons.

OSCILLOSCOPE INTERFACE
- If the device deals with fast signals, implement a dedicated oscilloscope interface (with trigger and reference signals and monitor outputs) for remote analysis under unknown conditions, operated by a non-expert.

NEED FOR A CONTACT PERSON
Contact person has to
- Speak a language known to the developer
- Know the system roughly
- Be interested that the system is operational
- Normally be near the place where the system is located
- Have enough time to service the system if necessary
- Be able to operate tools like oscilloscopes needed for service

HUMAN COMMUNICATION
- Video conference?
- Video communication for 2 persons?
- Special document exchange (2 persons writing on a common drawing area on the computer screen?)
- Phone calls?
- Photos of the environment?
- Short videos?