The **D**etector **S**afety **S**ystem for LHC Experiments

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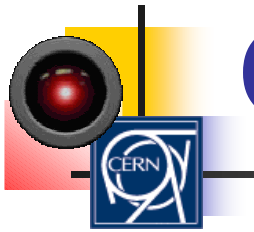
The DSS Team

LHC Machine Group Meeting, October 11th 2002



Outline

- Experiment Safety
- The DSS
  - Functional Requirements
  - Experiment Needs
  - Design and Architecture
- Conclusions and Outlook

3x Experiment Safety

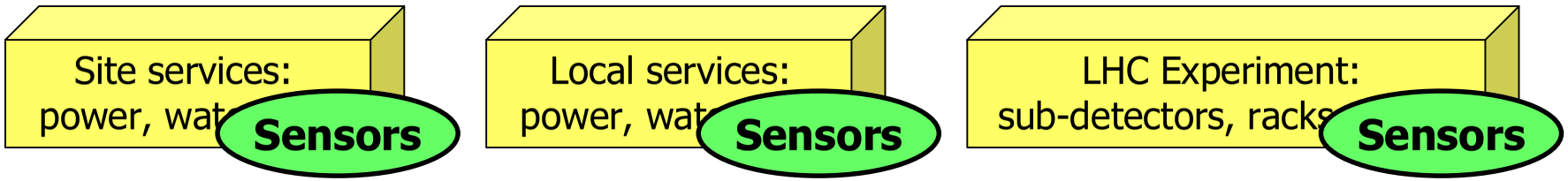
The LHC experiments and their sites, e.g.

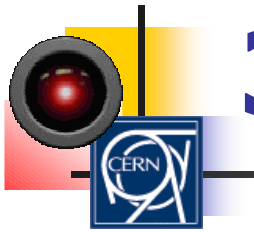
- (sub-)detectors,
- gas systems,
- magnets,
- power distribution,
- racks,
- crates

will be the **equipment** to be acted upon by the control and safety systems.

Technical Services provide power, water, gas (site services) and distribute them to the different locations (local services).

Hardware Layer





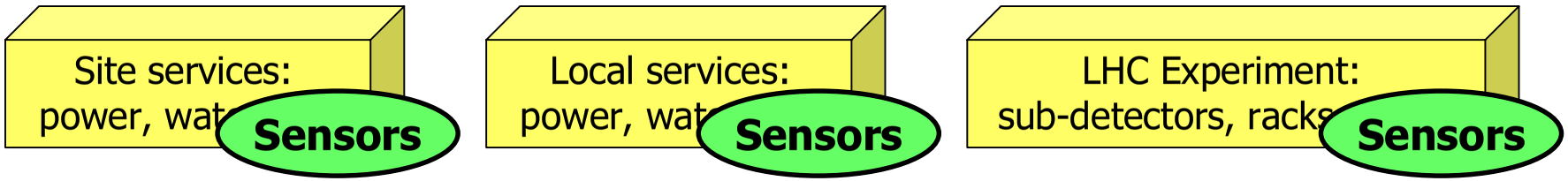
3x Experiment Safety

Sensors for
- temperature (equipment, ambient air, water),
- humidity,
- water-flow,
- sniffers,
- watchdog signals of the sub-detectors

monitor the state of the equipment.

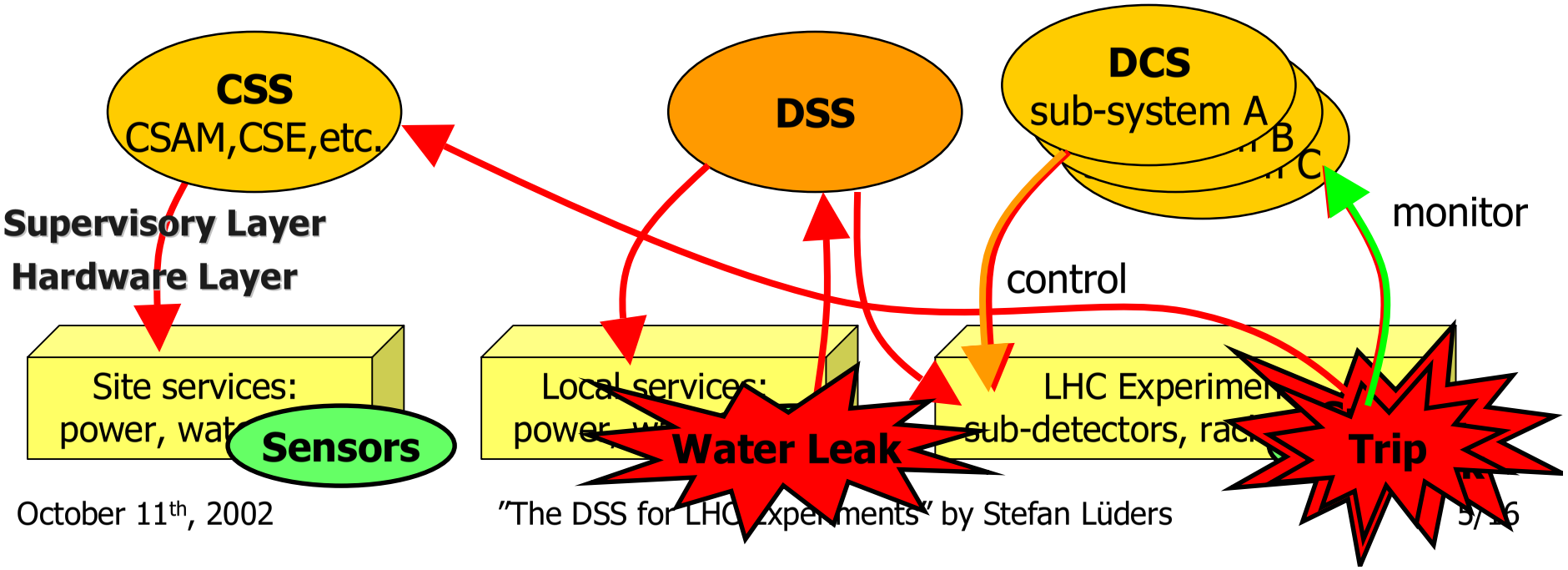
There are **dedicated sensors for the different** safety and control **systems**.

Hardware Layer



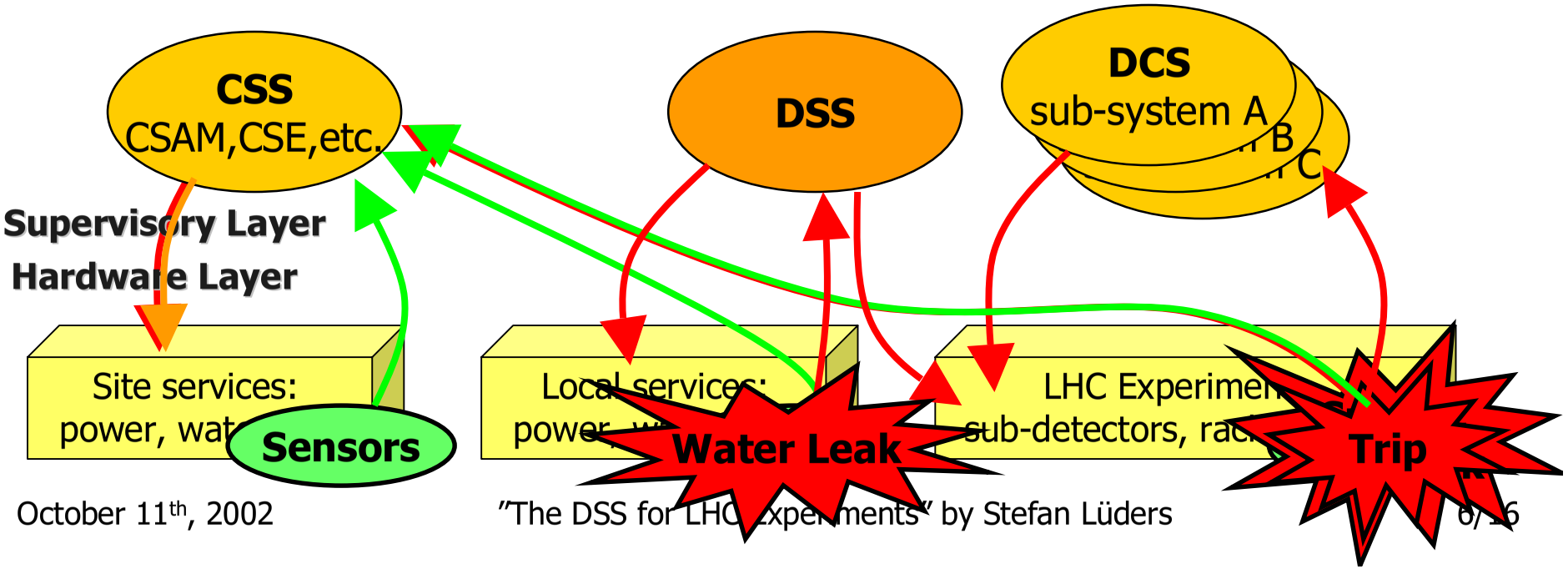
3x Experiment Safety

The **Detector Control System** (DCS) is responsible for the overall monitoring and control of the detector.
It might initiate corrective action to maintain normal operation.
All DCS sub-systems are interconnected.



3x Experiment Safety

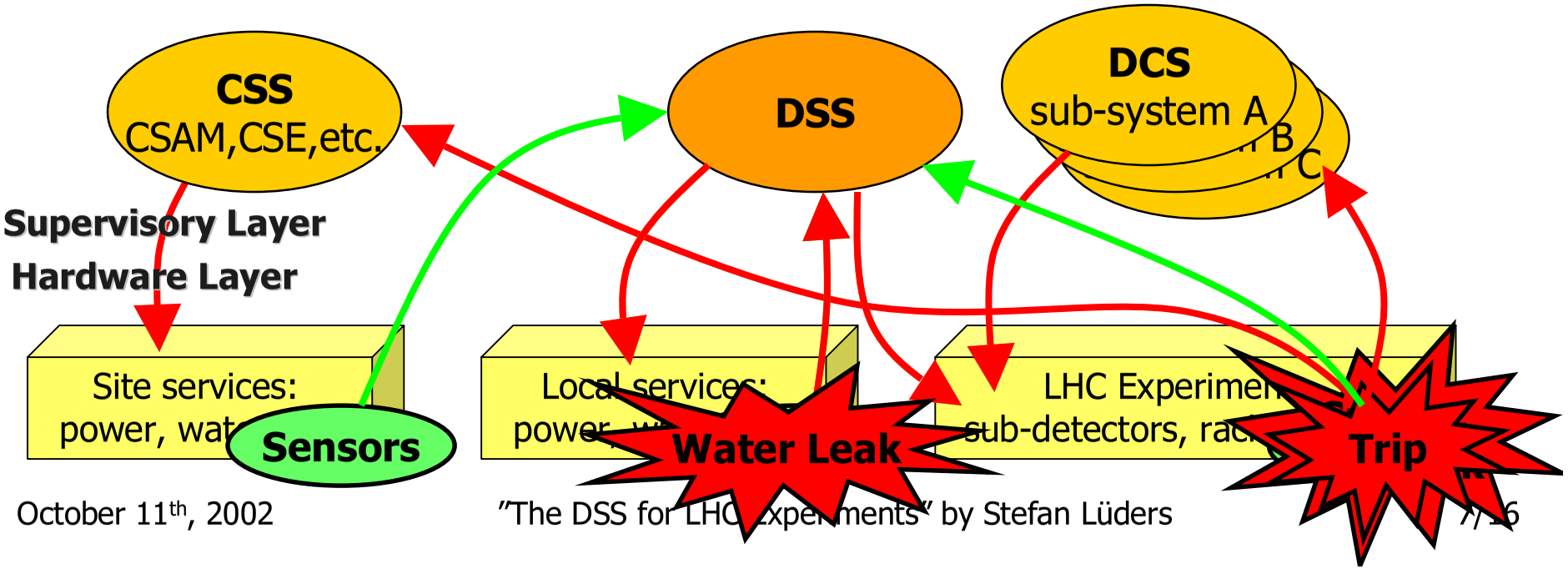
The safety for personnel (alarms-of-level-3) is ensured by
the **CERN Safety System** (CSS).
It has its own sensors.

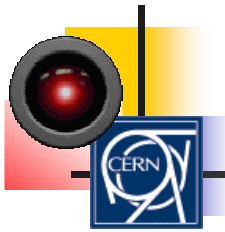


3x Experiment Safety

The DSS complements CSS and DCS:

"The DSS is a system to safeguard the experiment.
As such, it acts to prevent damage to the experimental equipment when a serious fault situation is detected (e.g. temperature too high, water leak…), inside or outside of the detector…"

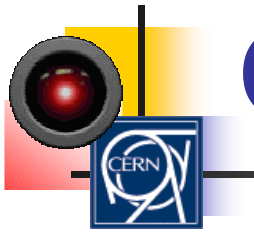




Scope and **G**oal: An **O**ptimization **C**hallenge

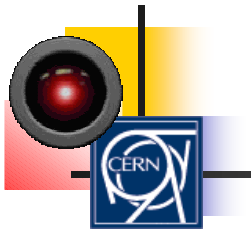
The DSS should…

- protect experimental equipment
- improve the experiment's efficiency by
  - preventing situations leading to alarms-of-level-3 handled by CSS
  - decreasing downtimes due to failures
- not cost too much
  - consider it as an insurance policy



Constraints for **DSS**

- easy integration
  - into the controls system of the experiment
  - of sub-detector safety systems
  - of subsystems (racks, gas, magnets, …)
- adaptability
  - to different needs of the four experiments
  - to evolving experimental environments
- maintainability



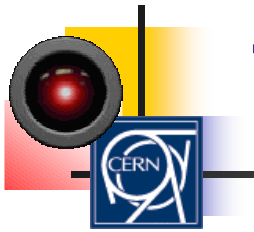
The **DSS** **F**unctional **R**equirements

The DSS functional requirements have been evaluated by the four LHC experiments in a joint WG, and are described in CERN-JCOP-2002-012:

http://itcowww.cern.ch/DSS/StG/Minutes/25-04-02/DSSFRD_20020425.pdf

"A Detector Safety System for the LHC Experiments"

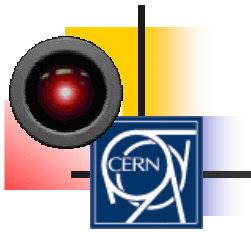
The WG was chaired by Philippe Gavillet



The **DSS** **F**unctional **R**equirements

The DSS is a **standalone system** and must be…

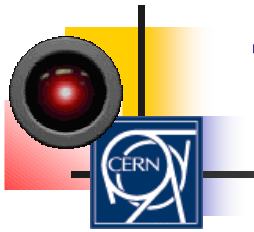
- highly reliable
- highly available
- as simple and robust as possible
- rapidly re-configurable by experts
- self-checking for consistency



The **DSS F**unctional **R**equirements

The DSS Front-End…

- will have its own power sources and additional sensors
- will be based on PLC technology
- will check and filter the sensor inputs
- will react immediately and always autonomously on fault conditions indicated by the sensors



The **DSS F**unctional **R**equirements

The DSS User Interface (Back-End) will…

- be based on the JCOP Framework and PVSS
- monitor and control the Front-End
- allow an easy definition of the input parameters and the actions performed in case of failures through controlled access (the "Alarm/Action Matrix")
- displays / logs alarm states, warnings and related info

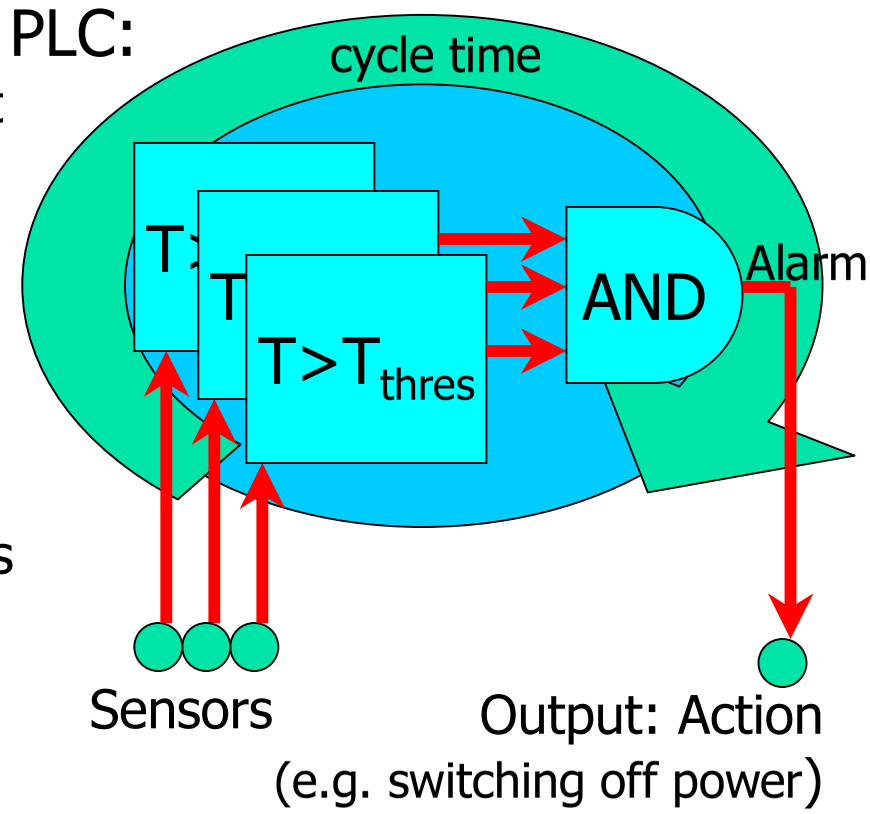
The **A**larm/**A**ction **M**atrix

The PLC loop:

- PLCs continuously monitor the input sensors
  - e.g. temperatures, water / gas flows, sub detector status
- input parameters are compared to programmable thresholds
- several conditions can be logically combined. Their fulfillment produces an alarm

End-of-loop

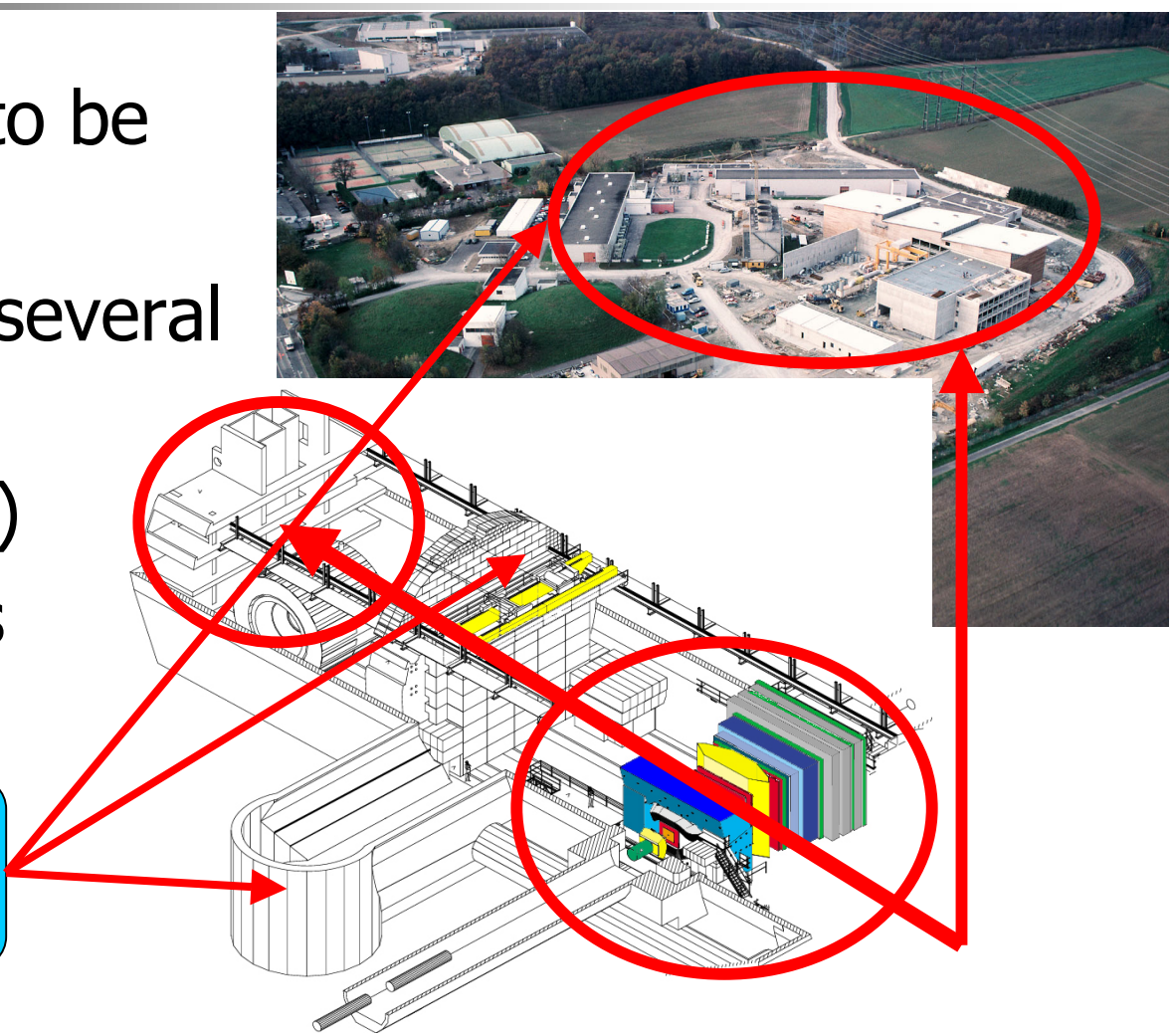
- alarms trigger defined actions
- actions are on a coarse level (e.g. cutting power for rack *rows*)



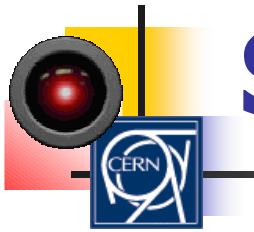
Experiments Needs

- 200 to 800 inputs to be monitored
- sensors located in several buildings

  (caverns & surface)
- 100 to 200 outputs



Geographically distributed system



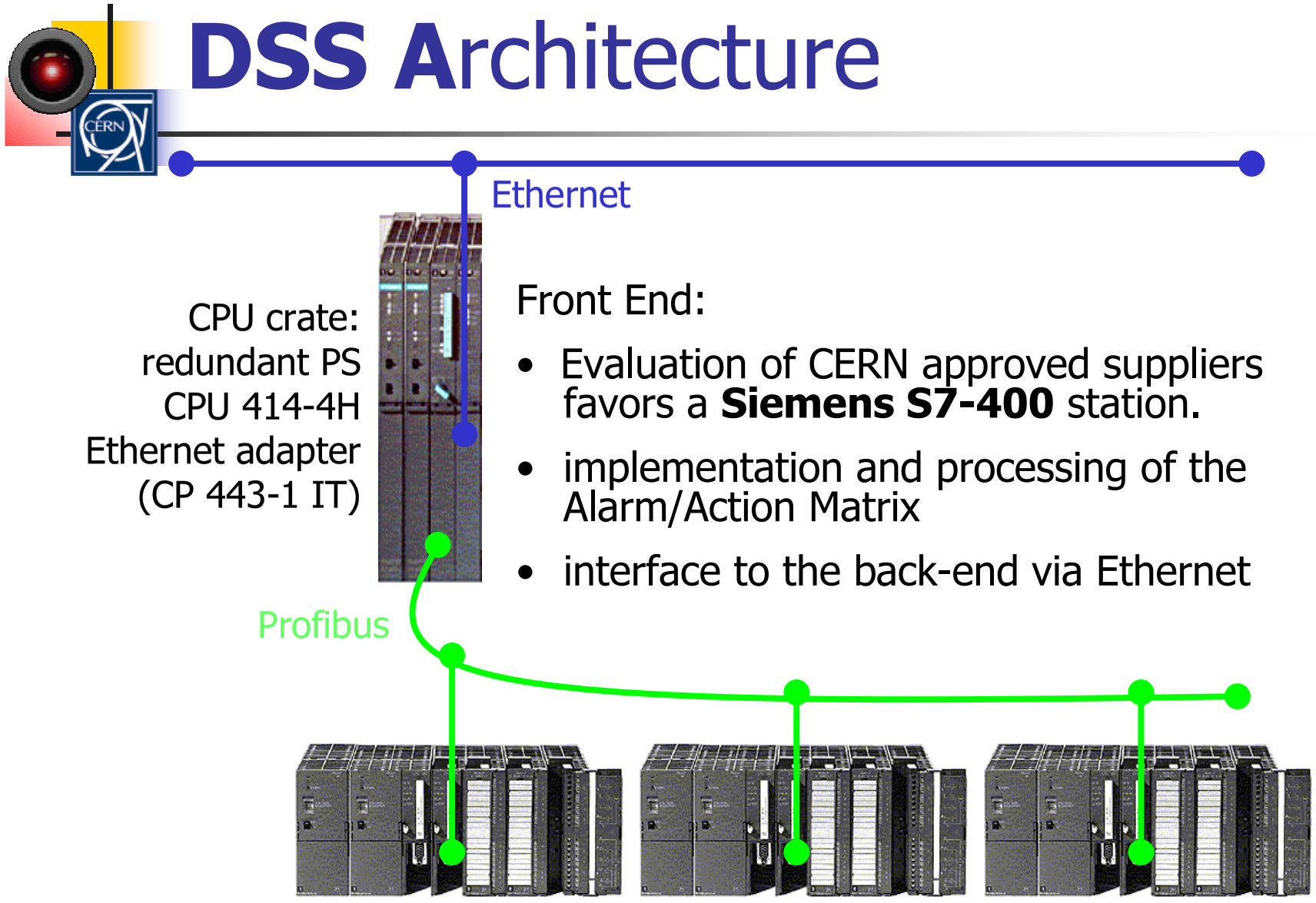
System Choice

Evaluation of CERN approved suppliers (Schneider & Siemens)

- both offer systems close to our HW requirements
- Siemens allows **easier** system **modification**
- Siemens **redundancy strategy** more convincing
- Siemens **local bus** (Profibus) is an open standard
- **Prices** are nearly the **same**, except analog input modules (Siemens less expensive)
- **Excellent** HW and SW **support** so far from Siemens

Go for Siemens.

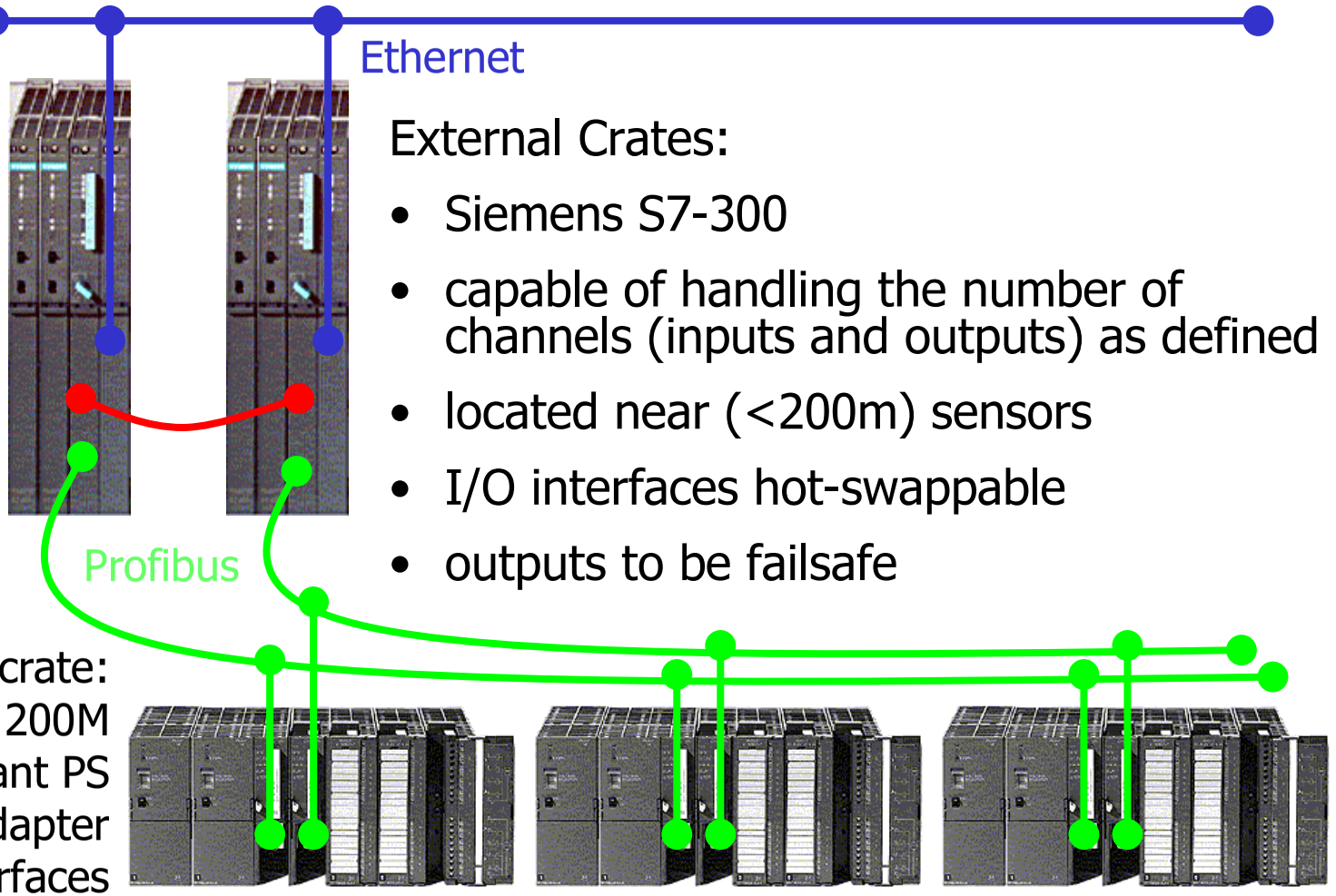
DSS Architecture



Front End:

- Evaluation of CERN approved suppliers favors a **Siemens S7-400** station.
- implementation and processing of the Alarm/Action Matrix
- interface to the back-end via Ethernet

DSS Architecture

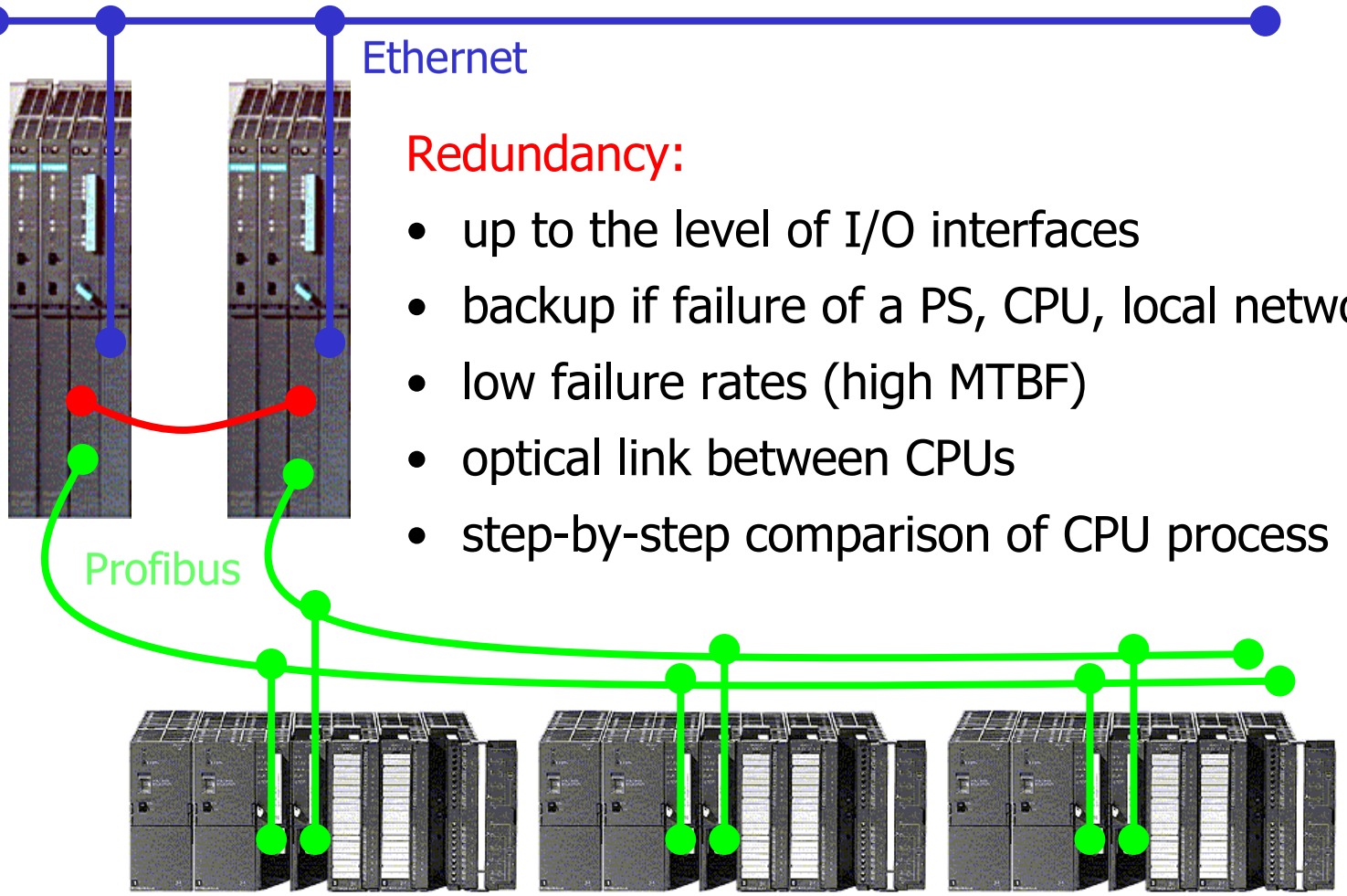


External Crates:

- Siemens S7-300
- capable of handling the number of channels (inputs and outputs) as defined
- located near (<200m) sensors
- I/O interfaces hot-swappable
- outputs to be failsafe

External crate:
ET 200M
redundant PS
Profibus adapter
I/O interfaces

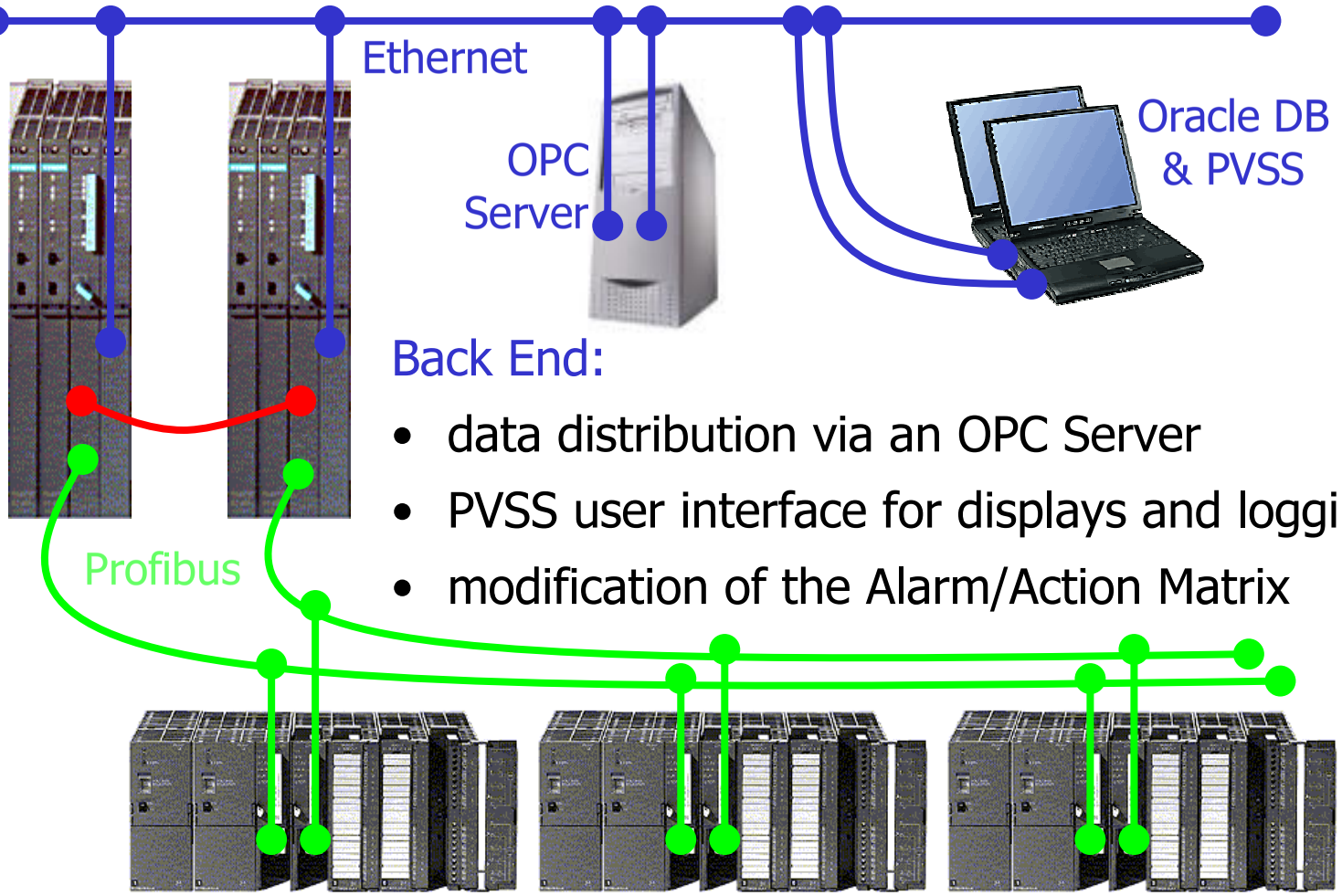
DSS Architecture



Redundancy:

- up to the level of I/O interfaces
- backup if failure of a PS, CPU, local network
- low failure rates (high MTBF)
- optical link between CPUs
- step-by-step comparison of CPU process

DSS Architecture



Back End:

- data distribution via an OPC Server
- PVSS user interface for displays and logging
- modification of the Alarm/Action Matrix

DSS Near Future

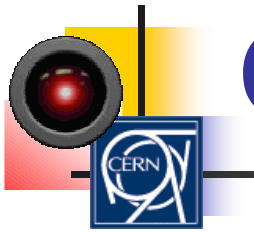
- The PLC hardware has been installed in the lab.
- Survey of useful temperature sensors (ambient air & water), humidity sensors, etc. has started.

Where is experience at CERN ?

The development of a prototype has begun.

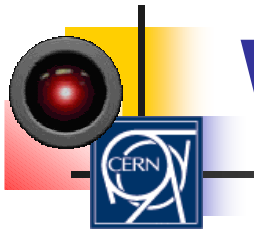
- The DSS database has been defined.
- Coding of the PLC program has begun.
- PVSS user interface programming will follow.

Prototype should be ready in May 2003.



Conclusions

- The Detector Safety System consists of a
  - Front-End: Siemens S7-400 redundant PLC
  - Back-End:
    OPC Server (data distribution)
    Oracle DB
    PVSS (user interface), using the JCOP Framework
- DSS prototyping has begun.
- A prototype system should be fully operational for its review in May 2003.



Where to find more Information?

- All documents and DSS presentations can be found on the DSS site
  http://cern.ch/proj-lhcdss

- Or visit us in our Laboratory: 14/3-030