Automatic inventory and configuration management tools for the LHC power converter controls

S. Page, Q. King, Z. Zaharieva

CERN, Geneva, Switzerland

The Challenge

- As a group we are responsible for tens of thousands of pieces of equipment installed in ~1700 power converters around a very large (27 km) machine

- During the commissioning phase, there are many interventions to install and replace equipment

- Equipment must be tracked so we know its location and history

- Configurations and calibrations associated with equipment must be maintained in order to achieve required <u>machine performance</u>

- Interventions should take as little time as possible to optimise <u>machine availability</u>

Intervention Process

- A technician goes to the LHC tunnel and replaces a piece of equipment

- The tunnel is a remote location with limited computer access

- Through automation we can simplify the process and reduce the time needed for an intervention

- We ensure that equipment is correctly configured

Configurable Items

Magnet circuits

- Loop parameters
- Resistance
- Inductance
- Limits

- Gains
- Limits
- Defaults

Voltage sources

Current transducers

- Calibrations
- Gains
- Temperature coefficients

- Calibrations
- Gains
- Temperature coefficients

ADCs

Equipment

- Equipment is physical hardware that may be installed in the accelerator complex

- Current transducers (DCCTs), voltage source electronics and controls hardware are examples of equipment

- The location of equipment must be tracked

- Equipment may have configuration and calibration values associated with it

Systems

- A system is a virtual 'slot' in the accelerator into which several pieces equipment may be installed

- A named power converter position in the accelerator is an example of a system

- Does not refer to a particular piece of physical hardware

- A system may have associated configuration properties, typically relating to the circuit

Types

- Equipment and systems must belong to a defined type

- A type identifies the model of equipment or the specification of a system

- The type of a system dictates which types of equipment may be installed in it

- A type may have values associated with it

- The property values associated with a type are common to all equipment or systems that belong to the type

# Inventory and Configuration Relationships
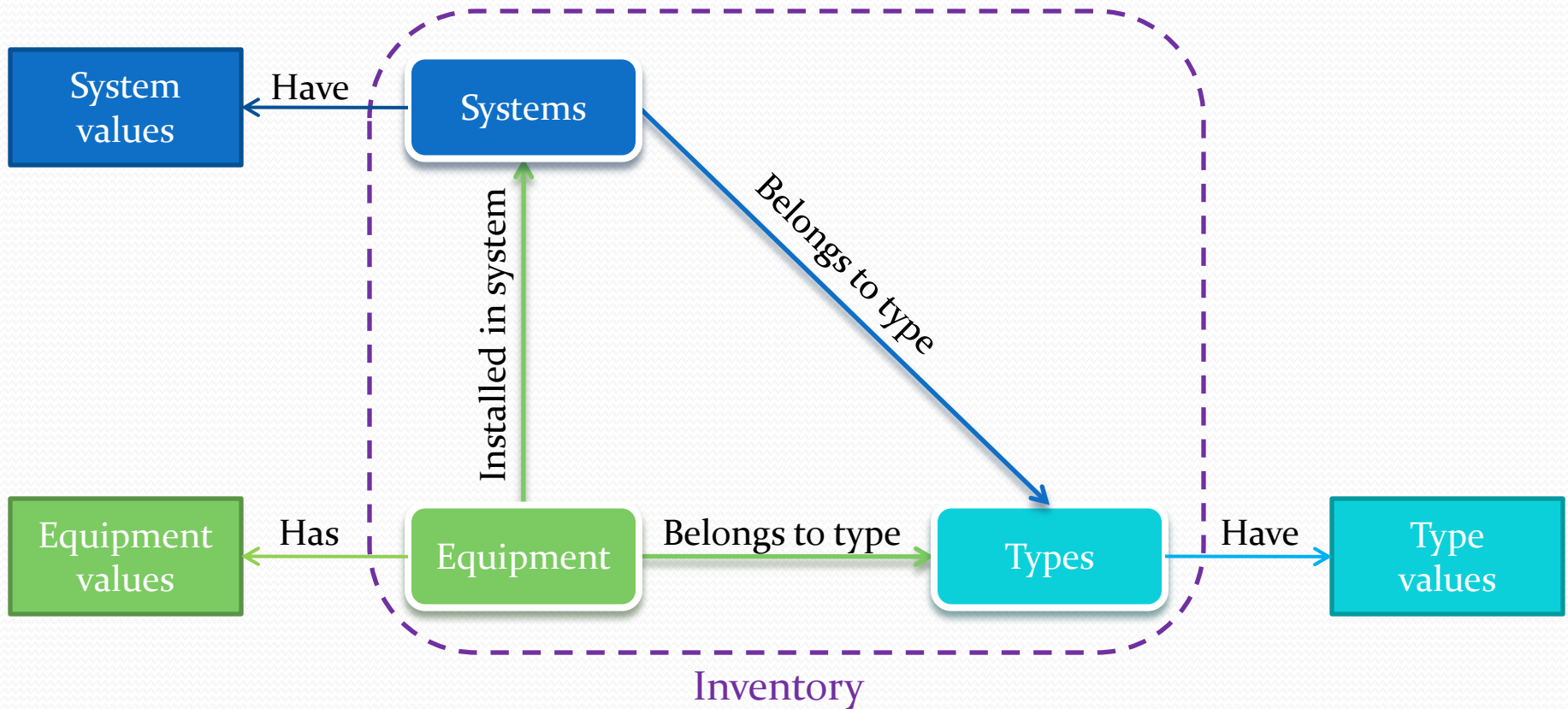
Equipment identification

- Each piece of equipment is tagged with a standard barcode that identifies its type and serial number and provides an LHC ID

CERN ab-po

Delta-Sigma Converter Module v10.1

HCRAMAD001-CR000050

- For power converter equipment we also attach a Dallas ID chip that can be read via the power converter controller and that is therefore remotely accessible
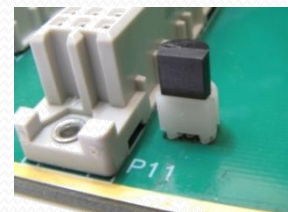
Function Generator/Controller

- Every power converter is controlled by an FGC

- Each FGC knows the mapping between all ID chips and LHC IDs

- The list of equipment installed in a power converter is therefore accessible through the control system

- Configuration takes the form of standard properties, accessible by any application through the control system

System Architecture
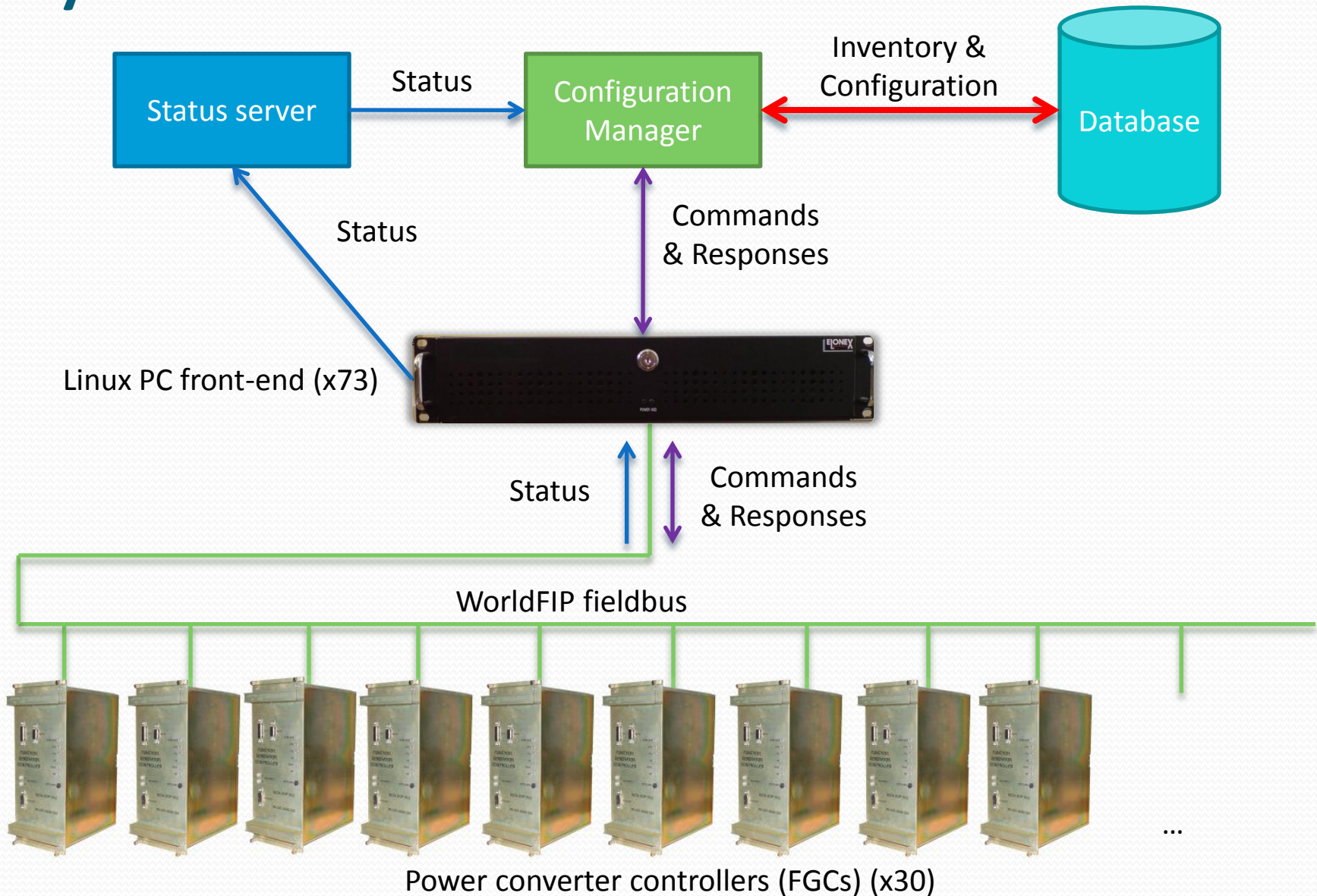
Modifying the Configuration

- Configuration can be updated through the control system by setting properties

- If a configuration is modified, the device is marked as being out of synchronisation with the database

- Once a modification has been tested, the user can either keep the change by triggering a synchronisation from the controller to the database, or revert it by synchronising in the other direction

Results

- Automated management of the inventory and related configuration has proven vital during LHC hardware commissioning

- Greatly simplifies the job of a technician when they install equipment

- Automatic inventory is used to perform an automatic configuration

- After new equipment is installed, the power converter controller is automatically loaded with the related configuration within a few seconds

- Some statistics:
  - 1975 power converter configurations managed
  - 49251 pieces of equipment
  - 342 types of equipment
  - 99642 property values

- The system is a success!

Thank you for listening.