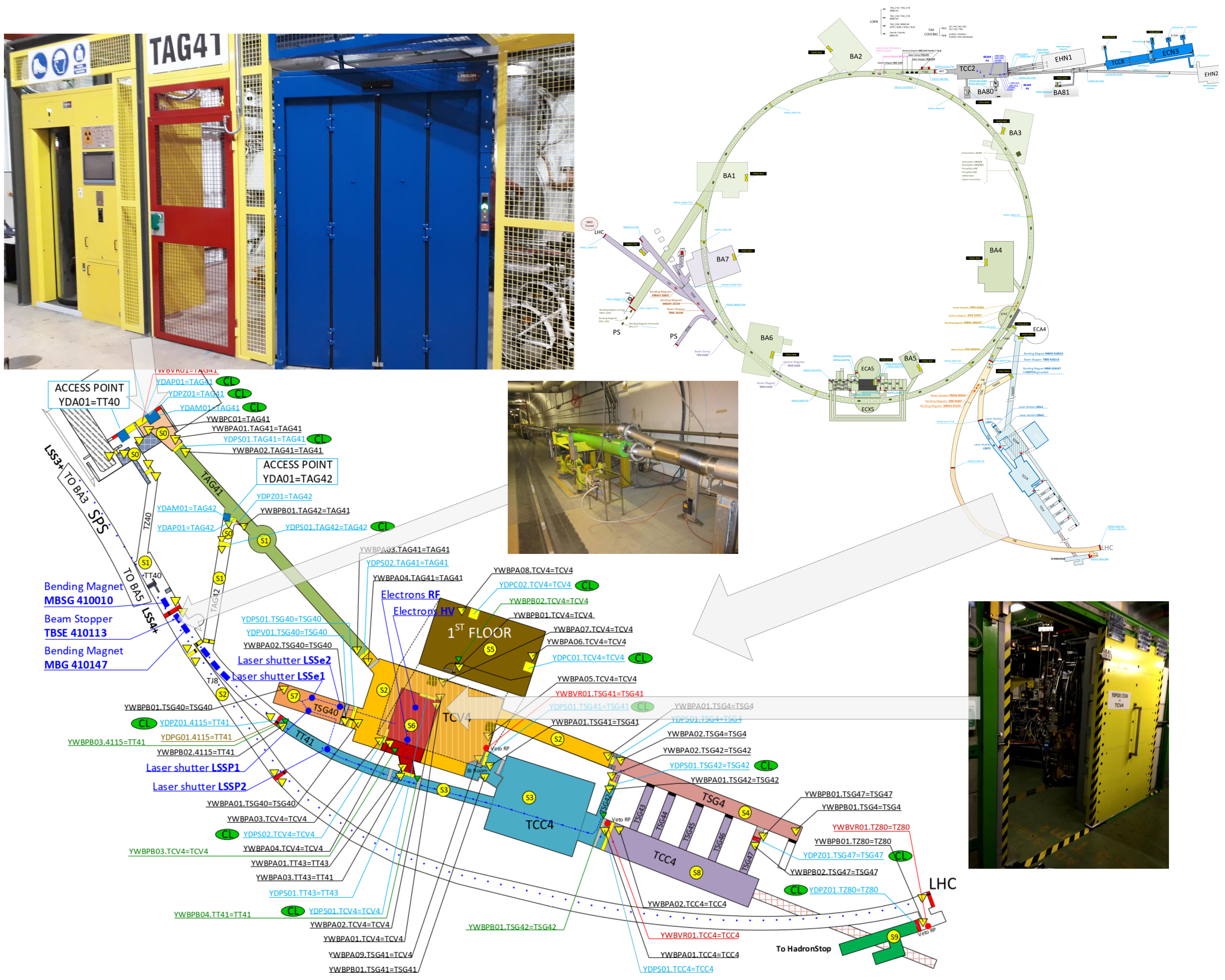
RENOVATION OF THE SPS PERSONNEL PROTECTION SYSTEM: A CONFIGURABLE APPROACH

T. Ladzinski, B. Fernandez Adiego, F. Havart, CERN, Geneva, Switzerland

MOPHA078



Engineering Challenge

Renovate the SPS Personnel Protection System (*a.k.a.* Access System) during the CERN Long Shutdown, providing an easily scalable and maintainable safety system.

Install sixteen access points, cable and instrument: 120 sector doors, 180 other doors, 350 patrol checkpoints, 240 junction boxes.

Design and implement in a way that adding/removing a new element such as a door, a beam stopper, an entire access zone (e.g. SHiP Experiment) will not require costly testing and validation of the entire safety software.

Assume the following maximum possible size of the installation:

Item	Maximum Config.	Current Config.
safety chains (including extraction chains)	16	6 (9)
access zones (sites)	32	16
access points *per* site	1	1
access elements *per* site	32	3-25
beam elements *per* chain	16	3
sectors *per* site	16	2-12

Configurable Safety System

Four layer-distributed control system based on Siemens F1500 series PLC. Global Interlock controller coordinates *n* site controllers (currently *n*=16), linked together by a dedicated fiber ring using Ethernet Profisafe protocol.

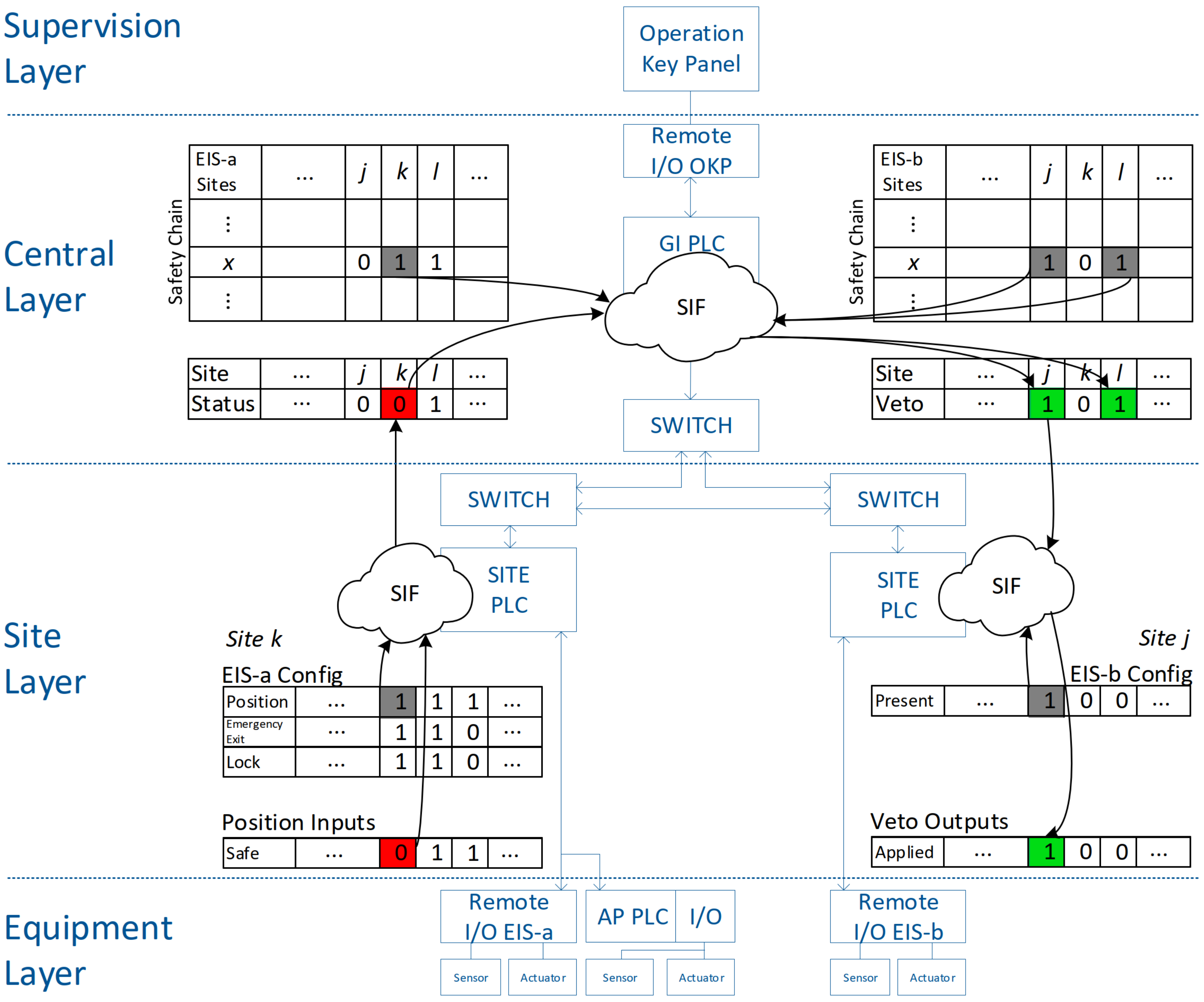
Field installation modeled with a set of configuration tables. Site configuration instantiated by changing the data blocks.

Safety Instrumented Functions (SIF) common to all the sites implemented in a reference program and validated for any site configuration. Possibility to add site specific safety functions (e.g. Laser hazard in the AWAKE Experiment).

The core of the safety program is developed using interlock matrices, where a status matrix is calculated locally in each site controller and is permanently fed to the global interlock controller which evaluates if a safety action (veto) should be applied to the elements of a given site.

Same reference hardware configuration in each site controller. The reference configuration is reduced to the actual one installed by using the Siemens Configuration Control Option Handling.

Already deployed in three SPS sites. AWAKE access zone exhaustively tested for protection from laser and electron gun hazards and put in service. Installation, testing and commissioning of the entire system ongoing, scheduled to last until August 2020.



EIS-a Sites	…	*j*	*k*	*l*	…
⋮					
x		0	1	1	
⋮					

EIS-b Sites	…	*j*	*k*	*l*	…
⋮					
x		1	0	1	
⋮					

Site	…	*j*	*k*	*l*	…
Status	…	0	0	1	…

Site	…	*j*	*k*	*l*	…
Veto	…	1	0	1	…

Position	…	1	1	1	…
Emergency Exit	…	1	1	0	…
Lock	…	1	1	0	…

Safe	…	0	1	1	…

Present	…	1	0	0	…

Applied	…	1	0	0	…

Extra Effort

- Complex development and testing. In addition to classical verification of output states against input changes for significant cases, need to use sophisticated techniques such as formal verification.
- From field devices to the controller: need translation tables & experience with option handling when commissioning.

Benefits

- Adding/removing an element as simple as adding/removing one bit from a configuration table.
- Test once for a reference site, run on any site.
- Possible to upgrade functionality without modifying the configuration.
- Adding a new site requires no software development.

CERN Beams Department

Industrial Controls and Safety Systems Group (ICS)

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