Project no. TIP5-CT-2006-031415

INNOTRACK

Integrated Project (IP)

Thematic Priority 6: Sustainable Development, Global Change and Ecosystems

D3.2.4/D3.3.5 – Draft requirement specification for the DLD and monitoring demonstrator

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Dissemination Level		
PU	Public	
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RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	X

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Glossary

Abbreviation / acronym	**Description**
DLD	Drive and Locking Device
LCC	Life Cycle Cost
MTBF	Mean Time Between Failures
MTTR	Mean Time To Repair
RAMS	Reliability Availability Maintainability & Safety
Trailing movement	Any vehicle movement through a switch where the direction of travel is from the heel to the toe of the switch (see Figure 1)
Run-through	A trailing movement through a switch from one direction (**B** in Figure 1), where the switch is set to accept trains from the other possible direction (**A** in Figure 1)
Trailable	Describes a switch which is capable of handling run-throughs, either as standard, or as a non-standard movement where minor damage may occur
Toe movement	Movement of the toe, when moved by the actuator. It is the distance between open and closed position at the toe (f_p in Figure 2).
Opening at the drive position	Movement of the switch rail at the drive position. This movement is less than the toe movement (f_d in Figure 2)
Throwing rod displacement	Movement of the throwing rod at the drive position. This movement allows the movement of the blade and can also include the movement of other devices (as locking devices in France). This movement is at least the opening at the drive position.
DLD	Drive and Locking Device
LCC	Life Cycle Cost
MTBF	Mean Time Between Failures

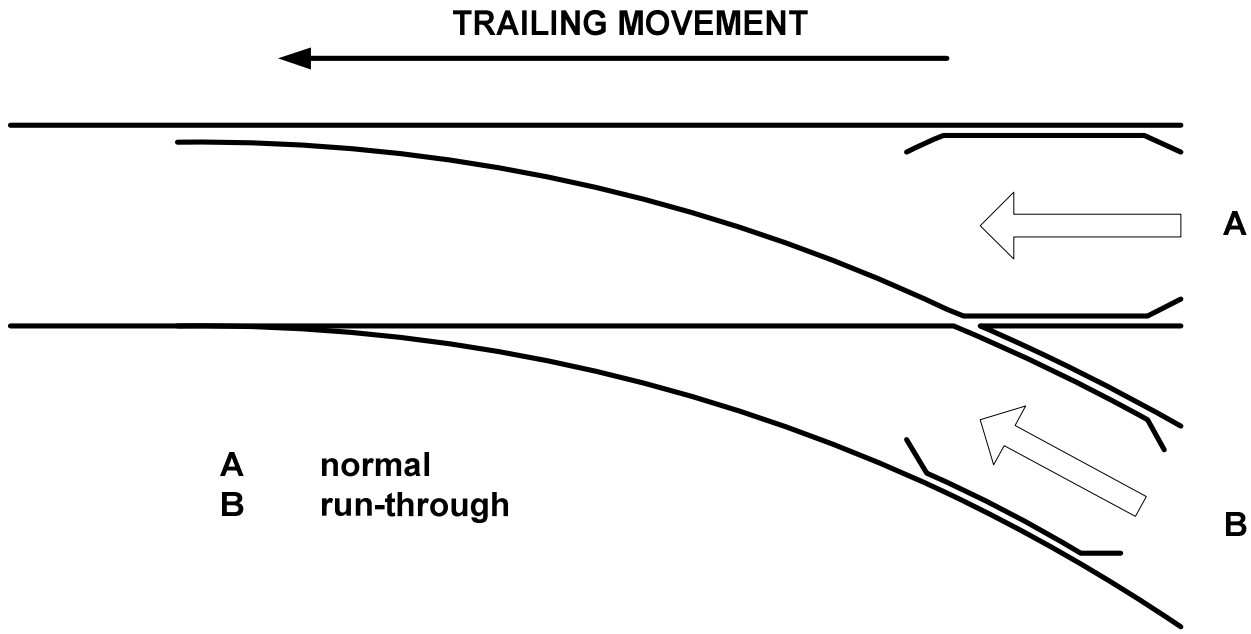

Figure 1 - Diagram of switch showing trailing direction

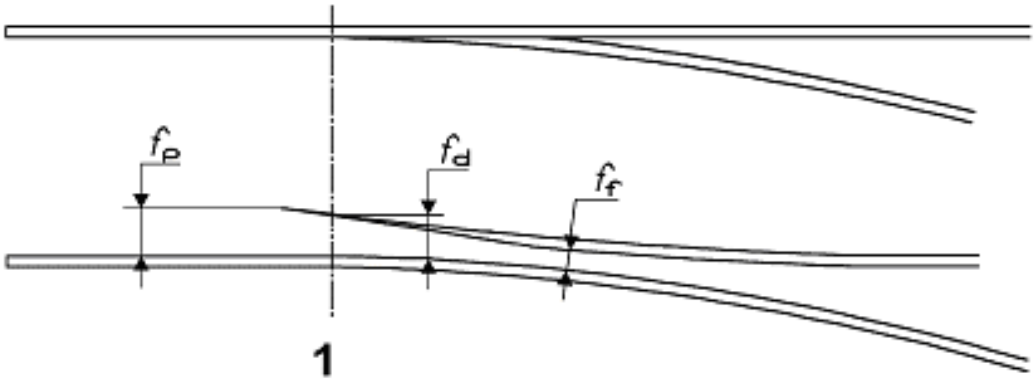

Figure 2 - Opening and flangeway

1. Introduction

This document contains the requirements for the SP3.2/SP3.3 switch control and monitoring demonstrator system. These have been agreed by the working party for SP3.2/SP3.3 and mandate the development of two separate demonstrators, one by VAE (in collaboration with Contraffic), and the other by Vossloh Cogifer.

The requirements have been formed into statements, each with a unique number. In some cases, requirements with a broad scope have been decomposed so that each can be tested separately. Decomposed requirements carry the number of their parent plus their unique child number. Parent and child numbers are separated by decimal points.

Not all the requirements are mandatory. Those which are mandatory are marked with an *'M'* beside the requirement title.

Following functional analysis of the system, the requirements should be decomposed so that all are single, testable statements, each of which applies to a different function or component. This will make it easier to determine whether the requirements have been fulfilled and therefore whether the demonstrator has achieved what was needed.

Background information on the DLD components used in the two planned demonstrators is provided in section 3.

2. Requirements

R1 ***M*** ***Architecture for interlocking and monitoring***

The demonstrator shall have the physical structure and components shown in figure 2.

R1.1 *M* *Architecture of the computer workstation*

The computer workstation shall be a Windows PC with specific hardware and software for the use of the demonstration. The final hardware specification is done during the installation of the demonstrators by the team.

R1.2 *M* *Architecture of intelligent switch assembly*

The intelligent switch assembly shall consist of an intelligent switch controller, a drive and locking device, and a system of sensors for condition monitoring.

R2 ***M*** ***Monitoring of the switch***

The demonstrator shall carry out condition monitoring of the switch.

R2.1 *M* *Collection of data*

The intelligent switch controller shall gather data from the switch system sensors.

R2.1.1 *M* *Measurement of force*

The force in the drive of each DLD shall be measured during operation of the switch.

R2.1.2 *M* *Measurement of motor current*

The current in the motor of each DLD shall be measured during operation of the switch.

R2.1.3 *M* *Measurement of hydraulic pressure*

If the DLD uses hydraulic components to throw the switch, the hydraulic pressure in each DLD shall be measured during the operation of the switch.

R2.1.4 *M* *Measurement of displacement*

The horizontal displacement of the drive rod shall be measured during the operation of the switch.

R2.1.5 *M* *Logging of digital signals*

Changes of state in digital signals such as detection outputs shall be logged as events whenever they occur.

R2.1.6 *M* *Transducer ranges*

All transducers shall have suitable ranges for making accurate measurements under faulty and fault-free conditions.

R2.1.7 *M* *Digitisation accuracy*

Digital data acquisition equipment shall have a resolution of at least 10 bits in the mode used to capture measured data.

R2.2 *M* *Communication of data to the interlocking*

The intelligent switch controller shall send measured data to the computer workstation.

R2.3 *M* *Determination of the status of the switch*

The computer workstation shall use the sensor data received to determine and display the status of the switch as a traffic-light system (see Table 1).

R3 ***M*** ***Interlocking and control***

The demonstrator shall act as a self-contained control system.

R3.1 *M* *Simulation of command and control*

The computer workstation shall simulate the actions of an interlocking, for the purposes of switch command and control only.

R3.2 *M* *Control of the switch*

The computer workstation shall control the switch by sending commands to the intelligent switch controller.

R3.2.1 *M* *Throw command*

The computer workstation shall be capable of sending, to the intelligent switch assembly, a command to throw from normal to reverse or from reverse to normal.

R3.2.2 *M* *First throw after trailed switch command*

The computer workstation shall be capable of sending, to the intelligent switch assembly, a command to throw the switch from normal to reverse or from reverse to normal for the first time after a run-through has taken place.

R3.2.3 *M* *Notification of command execution*

The computer workstation shall display confirmation of the acceptance or rejection, by the switch, of commands sent to the intelligent switch controller.

R3.3 *M* *Basis for commands*

The computer workstation shall determine the control commands based on the detection status received from the intelligent switch controller.

R3.4 *M* *Communication of throw commands within the intelligent switch*

The intelligent switch controller shall relay throw commands to the drive and locking device.

R3.5 *M* *Detection of the position of the switch*

The detectors shall continuously detect the position of the switch.

R3.5.1 *Detection of the close position*

The detector shall detect when either switch rail is closed against its corresponding stock rail (within the correct tolerance).

R3.5.2 *Detection of the open position*

The detector shall detect when either switch rail is apart from its corresponding stock rail by the minimum flangeway distance.

R3.5.3 *Detection of run-throughs*

The end position detector shall be capable of detecting run-throughs.

R3.5.4 *Detection of the locked close position*

The detector shall detect when either switch rail is correctly locked against its corresponding stock rail.

R3.5.5 *Detection of the locked open position*

The detector shall detect when either switch rail is correctly locked apart from its corresponding stock rail.

R3.7 *M* *Interoperable detection interface*

The end position detector shall have a DB standard four-wire interface for use when the switch is in operational service. (*so that it can interface with the existing signalling system)*

R3.8 *M* *Communication of detection signals within the intelligent switch*

When the demonstration is running, the end position detector shall send detection signals to the intelligent switch controller.

R3.9 *M* *Communication of detection signals between the switch and the interlocking*

The intelligent switch controller shall relay detection signals to the computer workstation.

R3.10 *M* *Confirmation of command execution*

The intelligent switch controller shall send a message to the computer workstation when it completes the execution of a command, to confirm that the command has been executed.

R3.11 *M* *Local control of switch*

The intelligent switch controller shall have an interface which allows it to receive throw commands locally, from a maintenance PC.

R3.12 *M* *Determination of the status of the switch*

The computer workstation shall use the detector data received to determine whether or not the switch is operating correctly.

R3.13 *M* *Display of switch status*

The computer workstation shall display the switch's operational status as red for non-operational and green for operational.

R3.14 *Monitoring of detection lines*

The intelligent switch controller shall monitor each detection signal separately (so that individual detection signals can be isolated for fault diagnosis).

R4 ***M*** ***Open standard for interlocking and monitoring***

The intelligent switch assembly and the computer workstation shall have standard interfaces so that assemblies from different sources are interchangeable.

R4.1 *M* *Demonstrator power supply interface*

The demonstrator's power interface shall be a 400 V AC three-phase supply with neutral and earth connections.

R4.2 *M* *Communication interface – connectivity*

The data link and physical layers for communication between the computer workstation and the intelligent switch assembly shall be implemented using Industrial Ethernet with real-time channel capability.

R4.3 *M* *Communication interface – device access*

Access to the industrial Ethernet link shall be restricted to authorised devices only.

R4.4 *M* *Communication interface – non-safety messages*

Monitoring data and maintenance messages sent between the computer workstation and the intelligent switch assembly shall be formatted according to a fixed XML schema which shall be agreed between all concerned parties.

R4.5 *M* *Communication interface – safety-critical messages*

Safety-critical messages and commands sent between the computer workstation and the intelligent switch assembly shall be coded using a suitable format which shall be agreed between all concerned parties.

R5 ***M*** ***External standards***

The standards and projects in the following list, plus any others deemed relevant, shall

be used as sources of information and guidance in the design of the demonstrator:

- Euro-interlocking project
- EN 50128 – Software for railway control and protection systems
- EN 13232-4:2005 – Railway applications — Track — Switches and crossings — Part 4: Actuation, locking and detection
- EN 50125-3 - Environmental conditions for equipment; equipment for signalling and telecommunications
- EN 50121-4 - Electromagnetic compatibility. Emission and immunity of the signalling and telecommunications apparatus

R6 ***M*** ***Message priority***

The priority of control and detection messages shall be higher than that of monitoring messages.

R7 ***M*** ***Interlocking and monitoring software modularity***

The software used to control the switch shall be effectively separated from the software used for monitoring.

R8 ***M*** ***Interlocking and monitoring hardware modularity***

No software changes shall be necessary in the computer workstation or the intelligent switch assembly, if the other is changed.

R9 ***DLD form factor***

The DLDs shall fit within standard sleepers as specified in D3.2.2.

R10 ***M*** ***Operating temperature range***

The demonstrator equipment shall be capable of functioning when the temperature inside any enclosures is between -20° and +70° C.

R11 ***M*** ***Type approval for operational service***

Components of the demonstrator intended for use in operational service shall be approved by the *Eisenbahn Bundesamt* (EBA). *(This does not apply to manually-operated switches)*

R11.1 *M* *DLD type approval*

The DLD shall be of a type approved by the EBA for operational service.

R11.2 *M* *DLD operational interface*

The DLD shall have a German four-wire interface.

R11.3 *M* *Position detector type approval*

The position detector shall be of a type approved by the EBA for operational service.

R11.4 *M* *Position detector operational interface*

The position detector shall have a standard interface to the German signalling system.

R12 ***M*** ***DLD movement range***

The DLD's movement range shall be adjustable in relation to the switch size for the opening gap at the drive position and for the throwing rod displacement.

R12.1 *M* *Opening gap at the drive position*

The DLD's range for the opening gap at the drive position shall be adjustable in relation to the switch size.

R12.2 *M* *Throwing rod displacement*

The DLD's range for the throwing rod displacement shall be adjustable in relation to the switch size.

R13 ***M*** ***DLD force capability***

The DLD shall be capable of exerting forces of up to 6 kN in each throw direction.

R14 ***Factory assembly of demonstrator switch***

The demonstrator switch shall be factory assembled, including the DLD, and moved to the installation site as a whole unit.

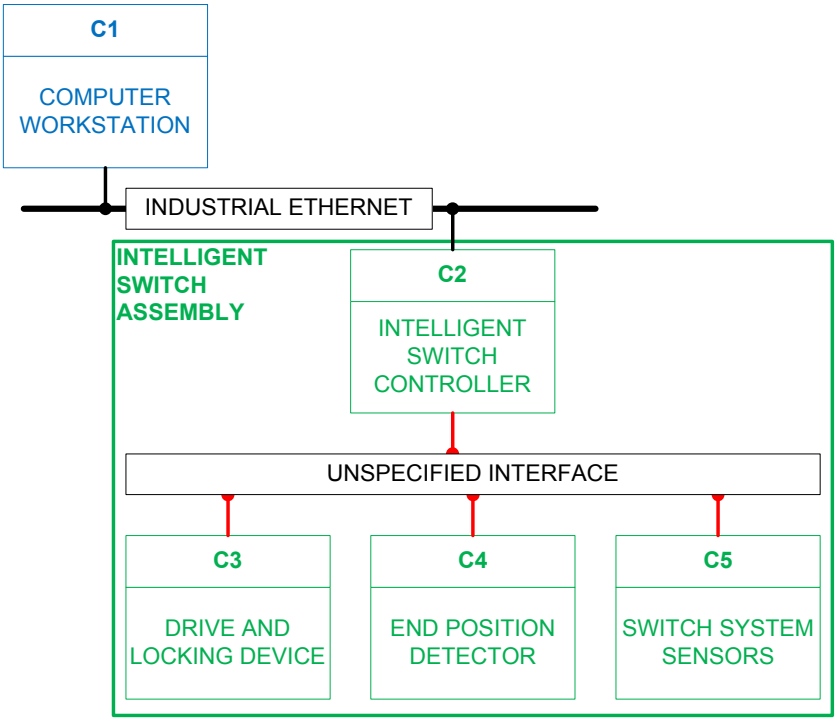

Figure 3 - Top level structure of the demonstrator

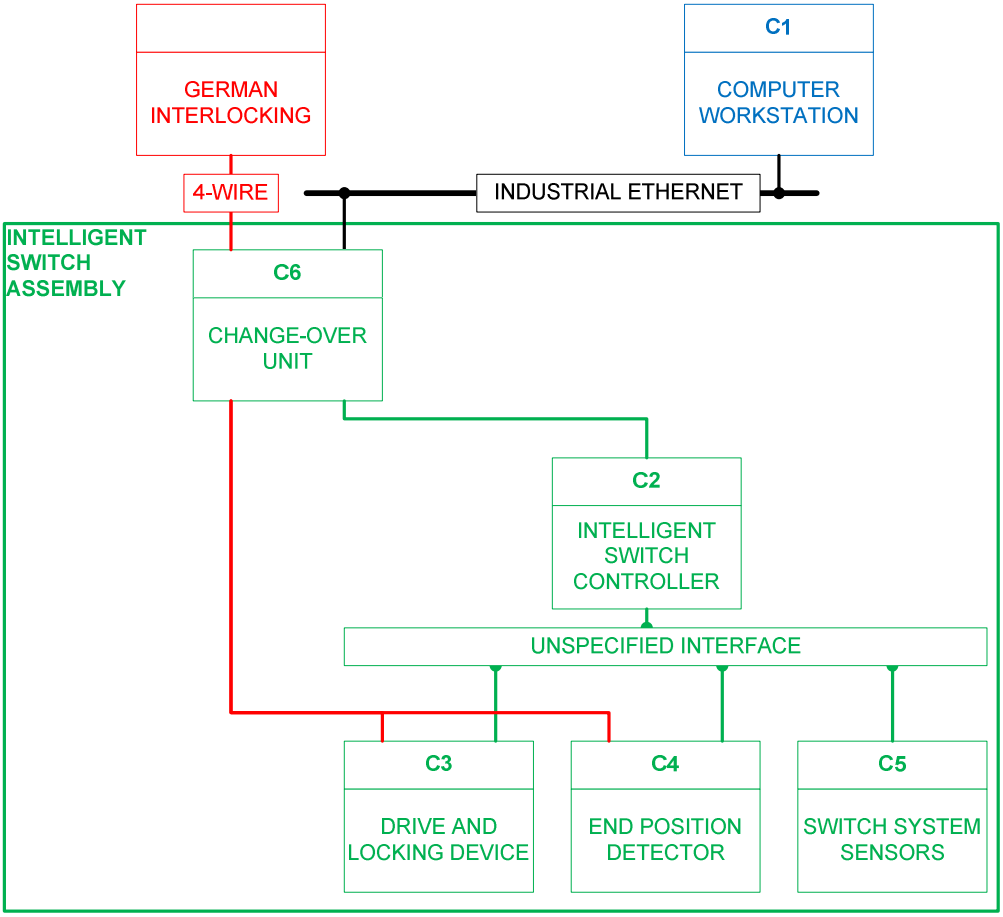

Figure 4 : Practical demonstrator structure

Traffic light colour	Corresponding status
Green	Switch is operating with no faults detected
Yellow	Fault present on switch but still capable of operating within signalling requirements
Red	Switch has failed (cannot operate within signalling requirements)

Table 1 - Status colour codes for the monitoring program

3. Changes made since submission of previous deliverables

The Key Parameters deliverable (D3.3.1) specified that vibration levels were to be measured by monitoring systems. Vibration shall not be measured by the demonstrator because it is a parameter which is only relevant when traffic is running over the switch. Since the demonstrator will be functioning in its full capacity only when the line is closed to traffic, there will be no significant vibration to measure. Therefore no requirement for vibration measurement is specified in this document.

4. Technical specifications of the DLD

4.1 General

Two demonstrators shall be installed based on existing mechanical DLD components. The purpose of the demonstrator is to show the capabilities and advantages of a monitoring system with an easy implementation standard. The concept shall also demonstrate independence of the type of actuation system (with two project partners as vendors: VAE and VCSA).

4.2 Demonstrator configuration

Two switch sizes/ranges are considered:

A UIC 60-500 switch

This switch shall be equipped with

- 2 actuators with integrated position detectors
- one position detectors between the actuators.

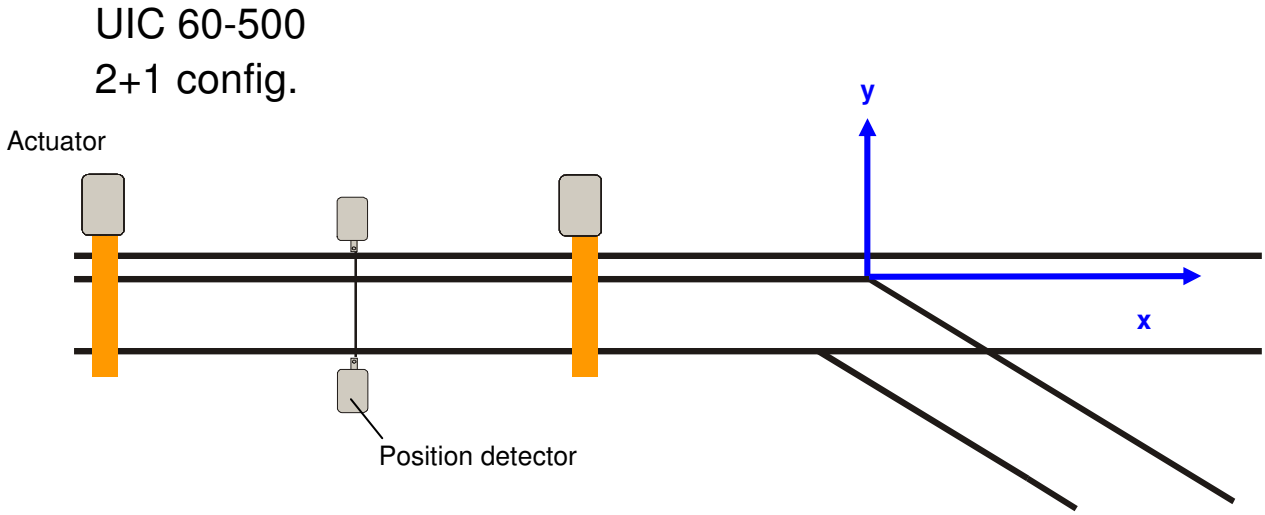

Figure 5 - Layout of the switch, showing the first possible configuration with two actuators and one position detectors

A UIC 60-760/1200 switch

Switches in this range shall be equipped with

- 3 actuators with integrated position detectors
- 2 position detectors between the actuators

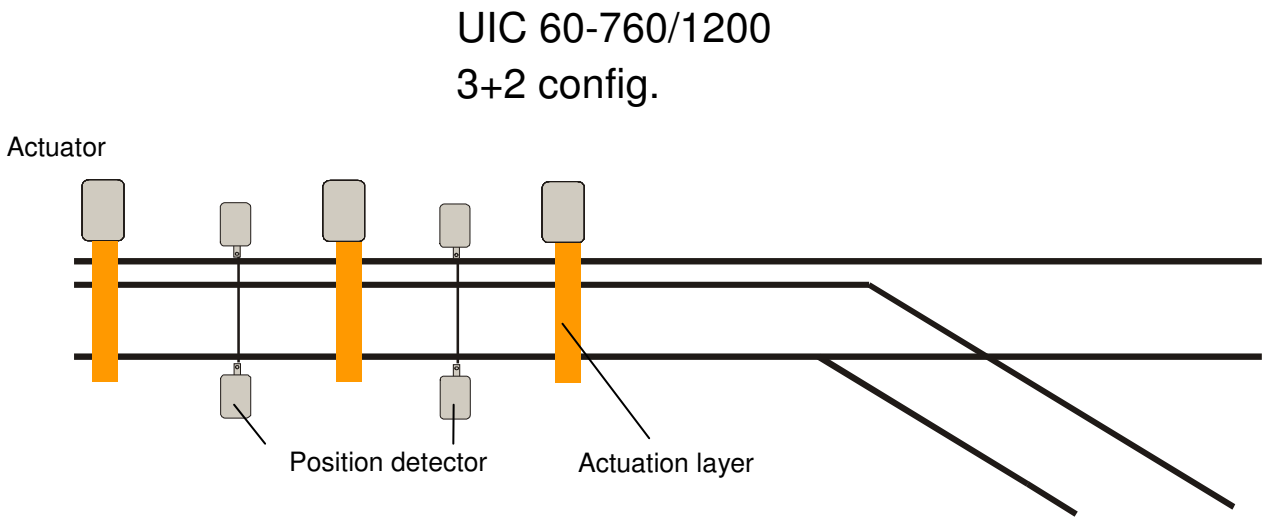

Figure 6 - Layout of the switch, showing the second possible configuration with three actuators and two position detectors

5. Conclusions

The INNOTRACK team decided to build a demonstrator based on the industrial Ethernet protocol.

For the development requirements have been described that allow the precise implementation of a DLD and monitoring demonstrator.

Additionally the formulated requirement can be used for future standards of interlocking and data transfer standards.

The demonstrator requirements are built on the knowledge/ work of the previous deliverables done in WP3.2 and WP3.3 and are in line with them. The use of a intelligent switch controller near the switch is highly recommended.