

CLEARSY

Safety Solutions Designer

AIX
LYON
PARIS
STRASBOURG

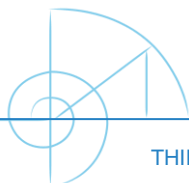
WWW.CLEARSY.COM

Hackathon
JUL2024

Subject Block Occupancy

PART II

Thierry Lecomte
R&D Director



THIERRY.LECOMTE@CLEARSY.COM



Attribution 4.0 Unported (CC BY 4.0)

Block Occupancy

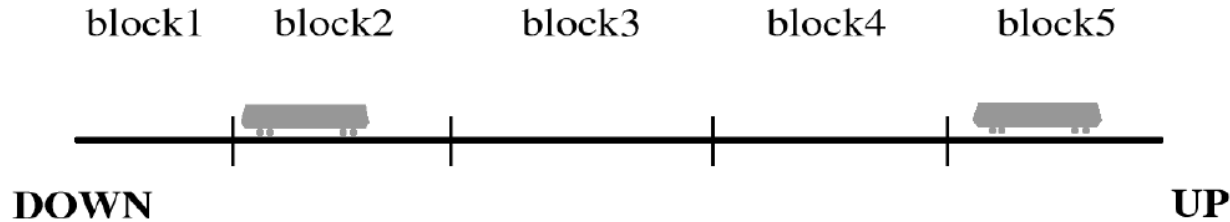
- ▶ This exercise is an example of how B can be used to develop a piece of software.
- ▶ It is based on a real example, although it has been simplified to fit the size of an exercise.
- ▶ Abstract iterators are used to simplify the modelling and implementations

Introduction: Train Movement Authority

- ▶ A train obtains permission to move forward in unoccupied sectors
- ▶ Based on the knowledge about the track occupancy

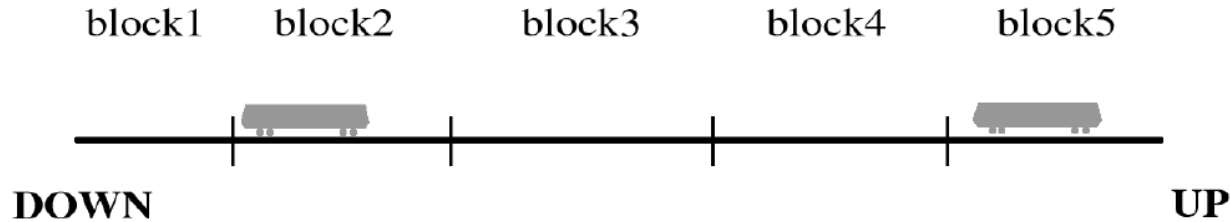


Subject: software development



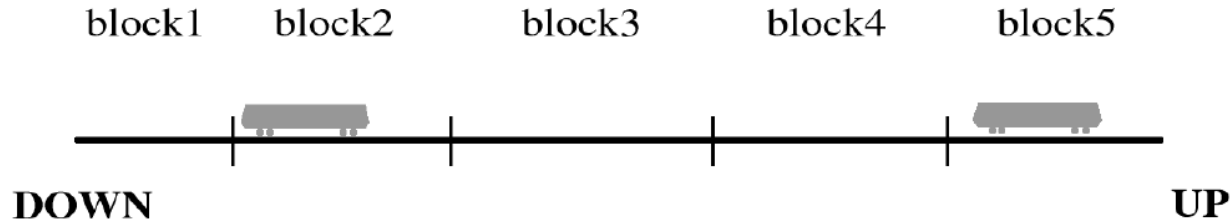
- ▶ This software controls a railroad line, divided into fixed blocks.
- ▶ The purpose of the functionality developed here is to manage safely block occupancy by trains, only by “sensing their presence”
 - ▷ There is no direct communication with trains, no GPS.

Subject: software development



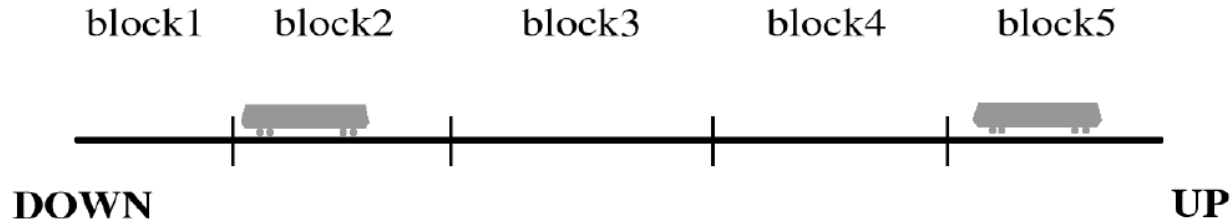
- ▶ A railroad line has two directions 'up' and 'down'.
- ▶ Each block may only be connected to one upward block and to one downward block. So the line is quite simple, since it has no switch.

Subject: software development



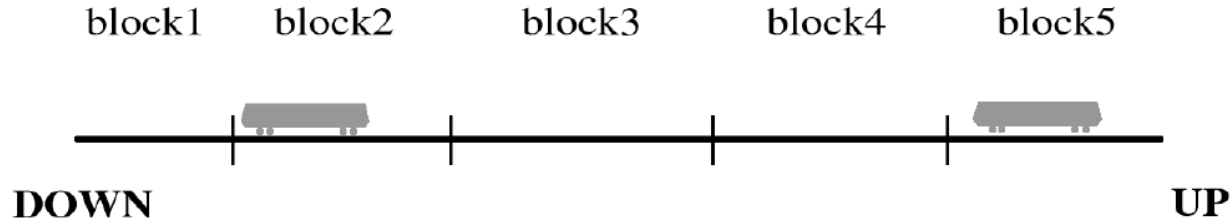
- The purpose of the functionality developed in this exercise is to establish safely, from the software point of view, which blocks are occupied by a train and which are free

Subject: software development



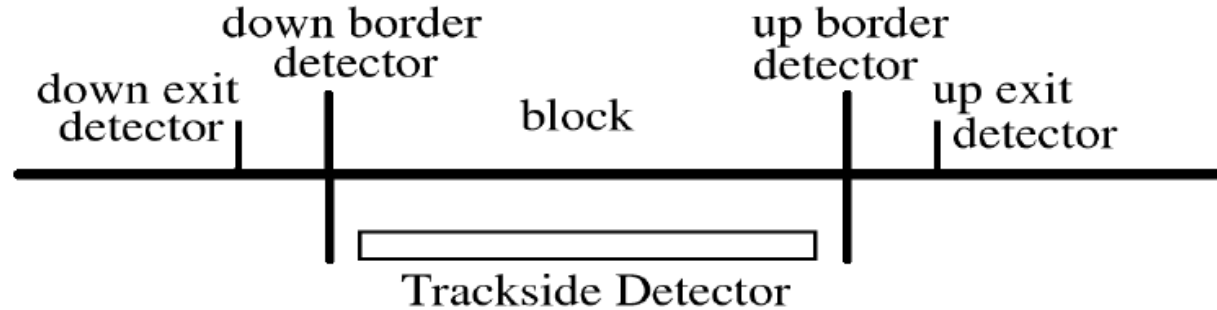
- ▶ Here are the basic principles given by the system analysis:
 - ▷ For each block a detector located along the track called Trackside Detector (TD) is used to detect trains. It has the size of the track. It does not return the exact position of the train
 - ▷ A train is equipped with an antenna located below the coach.
 - ▷ When the antenna is above a trackside detector, a signal inside the detector is produced, so the train presence may be detected.

Subject: software development



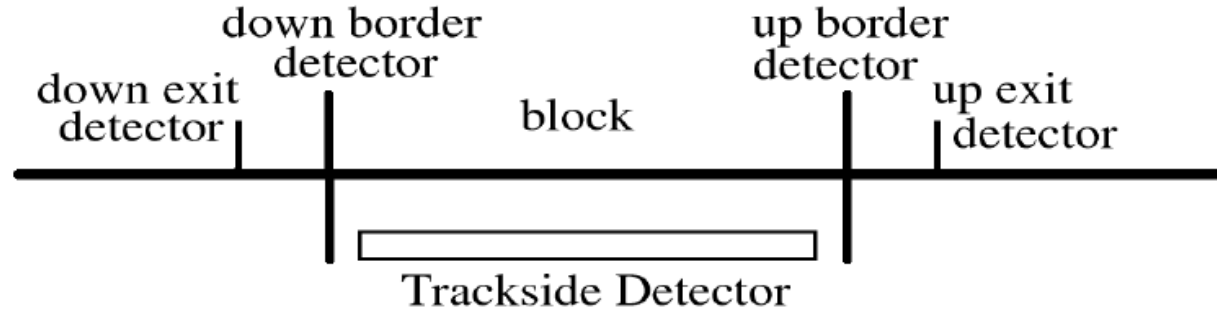
- ▶ Now building the software appears to be easy, since we just need to read for each block the state of its trackside detector.
- ▶ However, this solution raises two issues, both related with safety:
 - ▷ The information given by a trackside detector is not accurate enough on the border of detectors.
 - ▷ Trackside detectors (or antennas) may be faulty.

Subject: software development



- ▶ To overcome those issues, the following elements are added to the system specification.
 - ▷ A Border Detector (BD) .
 - ▷ Exit Detectors (ED)
 - ▷ The Trackside Detector Loss (TDL) alarm

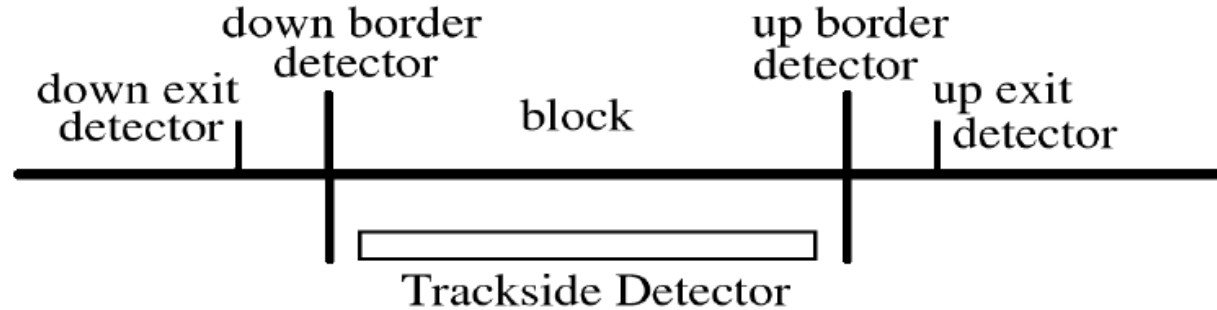
Subject: software development



► A Border Detector (BD) – detect absence/presence

- ▷ used at each borderline between two blocks to achieve accurate block occupancy detection.
- ▷ When a block trackside detector or border detector is occupied, then the block is considered to be occupied.

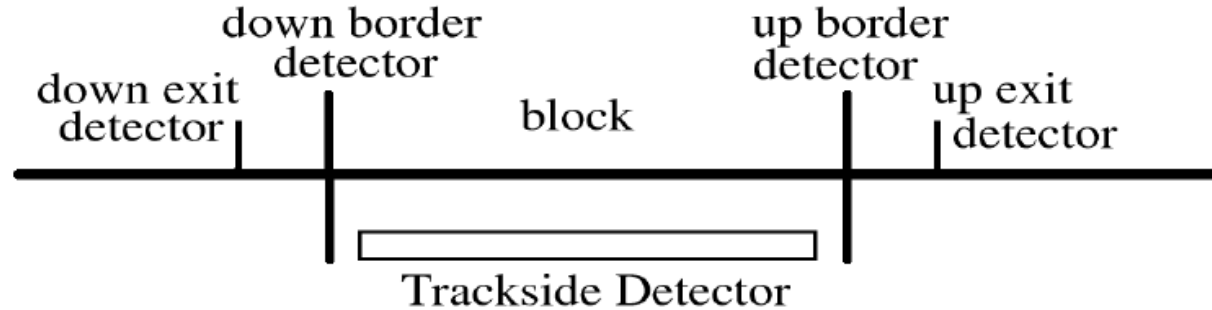
Subject: software development



► Exit Detectors (ED) – detect absence/presence

- ▷ located after a block border (in the upward block or in the downward block)
- ▷ used to detect trains leaving the block.
- ▷ A block is released on the falling edge of one of its exit detector.

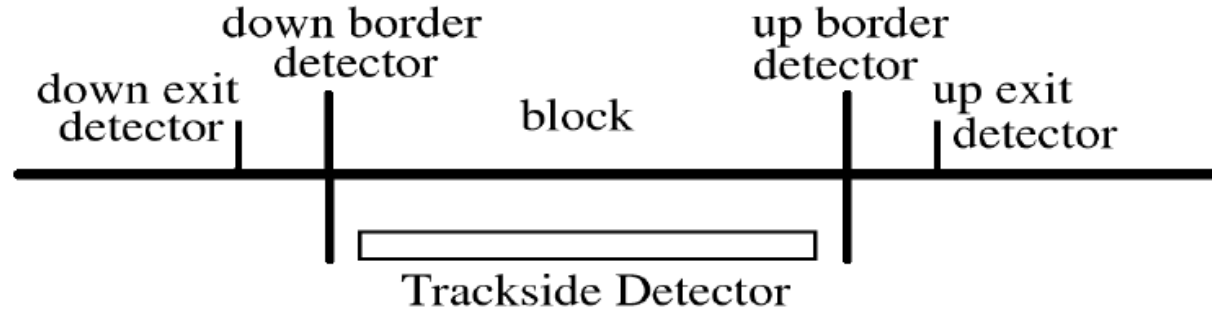
Subject: software development



► The Trackside Detector Loss (TDL) alarm

- ▷ set for a block when a trackside detector inconsistency happens.
- ▷ Such an inconsistency happens when a block trackside detector is free although it should be occupied.
- ▷ When a TDL alarm is set, the procedure to release it requires that an operator at the command center send back an alarm acknowledgement.

Subject: software development



- To avoid unjustified TDL alarm due to the lack of accuracy of trackside detectors, blocks may be masked for TDL alarm when trains are located near a block border.

B Project Architecture

