

CBTC TRAIN OPERATION OVER FAILED TRACK CIRCUITS

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Agenda

1. Presentation of CBTC system
2. Different types of track circuit failure
3. Methods of detection of failures
4. Train operation over a failed track circuit
5. Enforcement of operation restrictions
6. Resuming normal CBTC operation



What is CBTC?

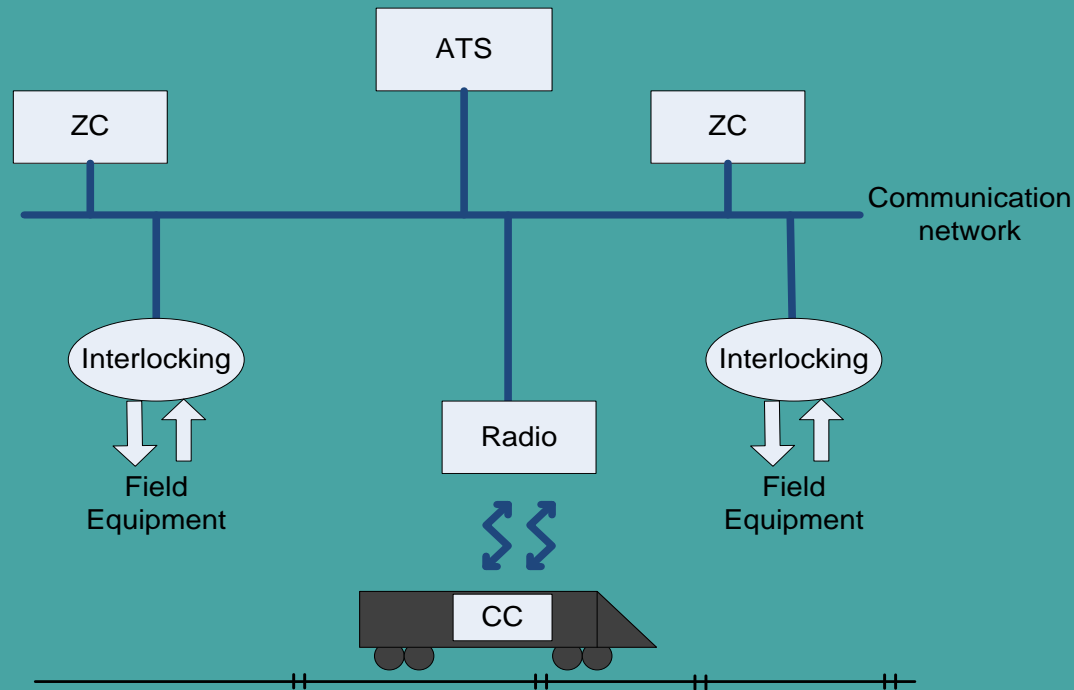
CBTC: Communication-Based Train Control

Basic principles:

- Two way communication through the radio between trains and wayside equipment
- Train location determined on board and sent to wayside equipment
- Wayside equipment in charge of determining Movement Authority Limits
- On board equipment enforces the limit

CBTC has 3 main subsystems

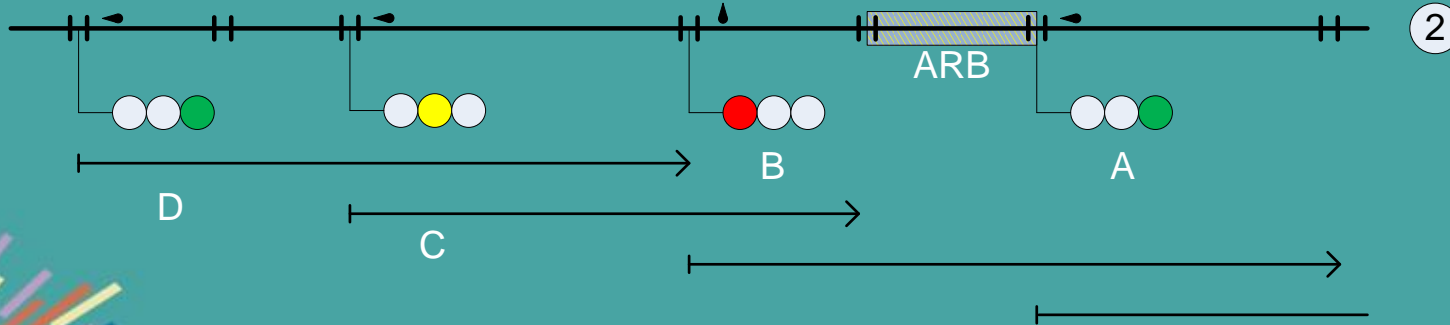
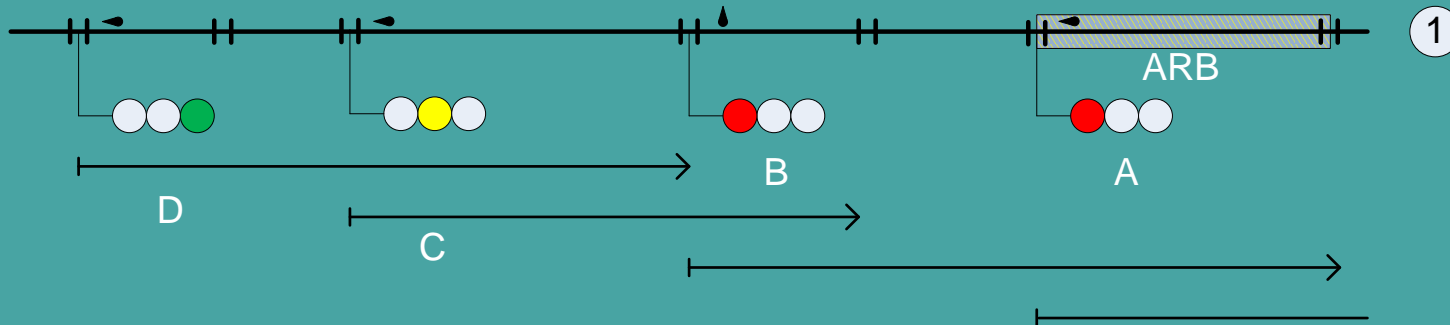
- CC: Carborne Controller
- ZC: Zone Controller
- ATS: Automatic Train Supervision



ARB: Always Reporting Block

- Track circuit reports occupancy even if no train is on the track circuit
- Safe side failure
- Possible causes: equipment failure, connection loose in wiring, power supply failure, broken rail, etc
- Relatively frequent failure

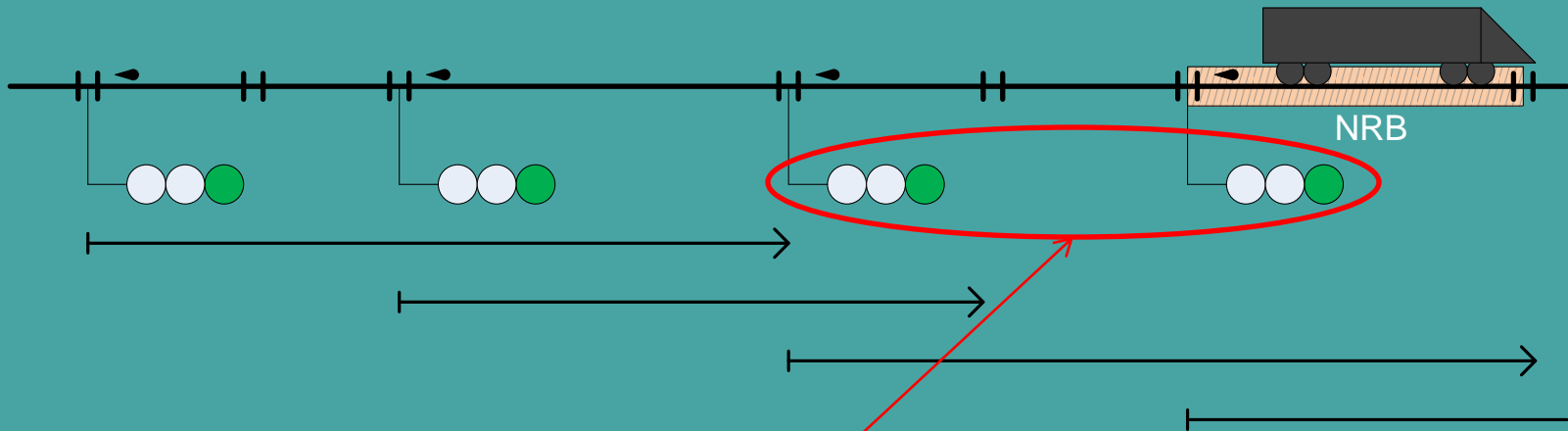
ARB is similar to train occupancy



NRB: Never Reporting Block

- Track circuit reports vacant even if a train is on the track circuit.
- Wrong side failure.
- Possible causes: human error during maintenance operation, environmental constraints, etc.
- Typically rare but possible failure.

NRB is similar to absence of train



The control line of those signals is occupied: signals should be red.

Use of track circuits in CBTC projects

- Not needed for CBTC operation
- Backup in case of CBTC failure
- Ability to detect non communicating trains
- Broken rail detection

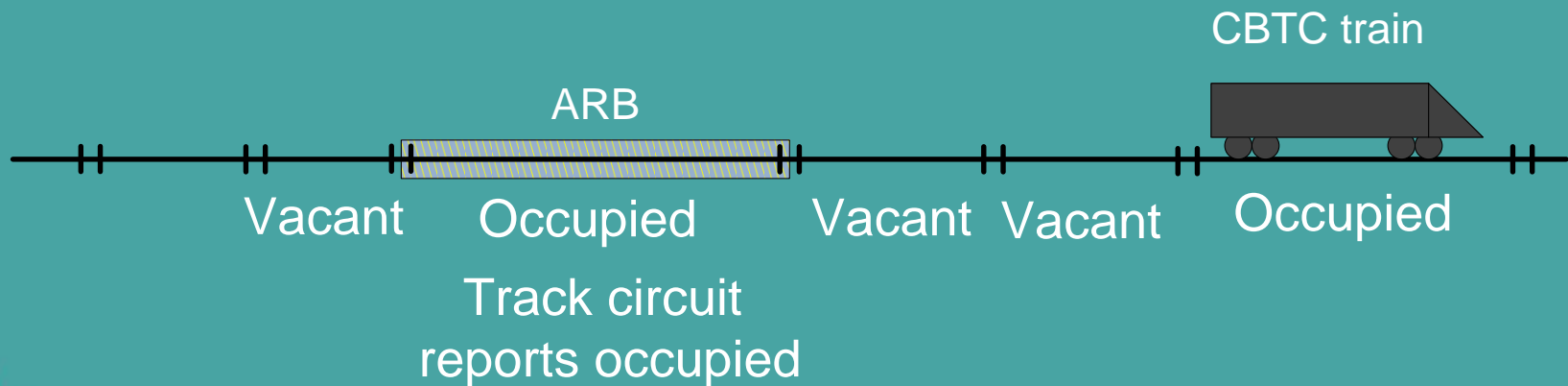
Detecting Track Circuit failures

Using Zone Controller train tracking:

- CBTC trains location reports
- Sequential track circuit occupancy for non CBTC trains
- Track circuit status, occupied or vacant from the signaling system

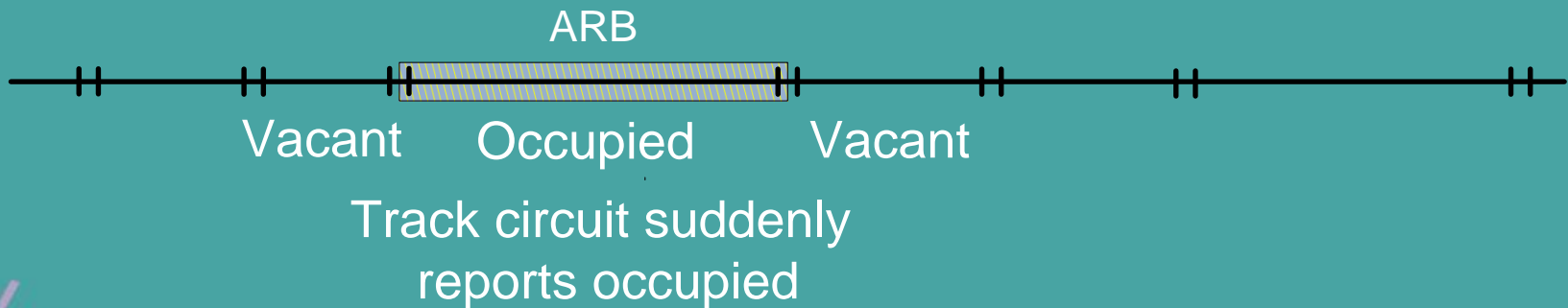
Detecting an ARB

- Track circuit occupied + no train reports being on the track circuit = ARB



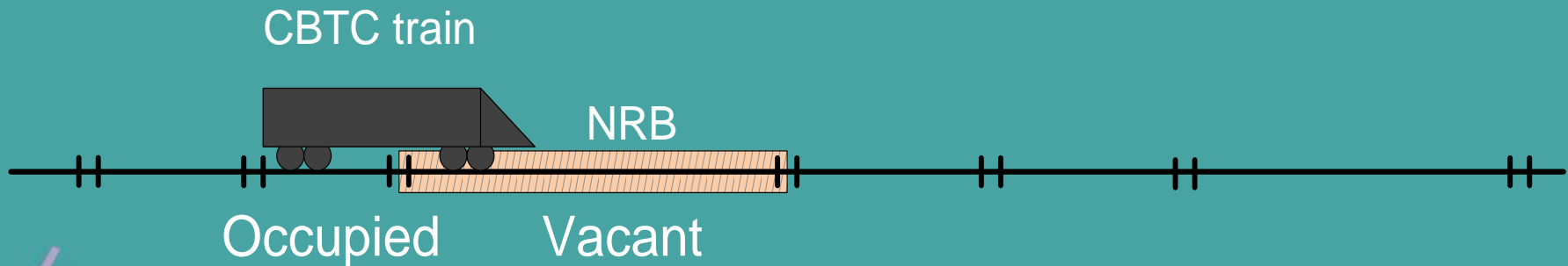
Detecting an ARB

- Sudden occupation of track circuit
- Not due to sequential occupation by non communicating train



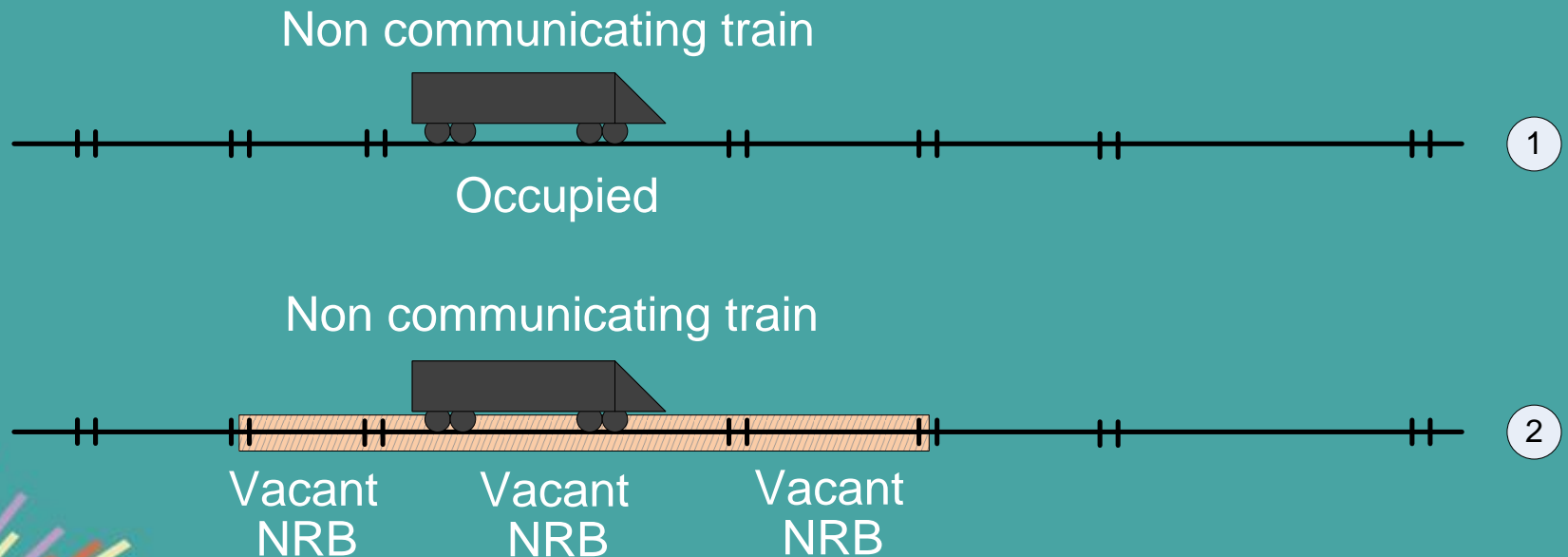
Detecting an NRB

- Track circuit vacant + at least one train reports being on the track circuit = NRB



Detecting an NRB

- Loss of sequential occupation of a non communicating train



Operation over an ARB

- Option 1:
 - No CBTC operation
- Option 2:
 - CBTC operation allowed at low speed
 - No Automatic Train Operation

Operation over an NRB

- NRB: No CBTC operation allowed
- Main reasons:
 - Potentially unsafe with several issues in the past
 - Agencies want to have Train Operator focusing on line of sight only

Enforcement of Restrictions

- On entire train length



1

CBTC Train arrives at the restricted zone. It travels at normal speed.



2

CBTC Train starts enforcing the restriction when its front reaches the zone.

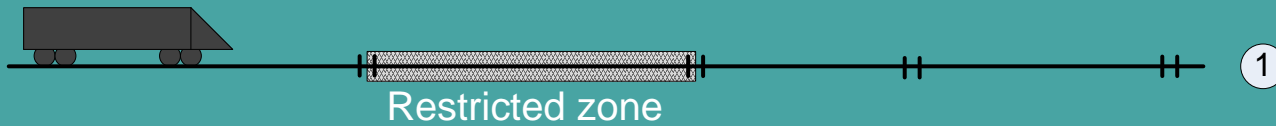


3

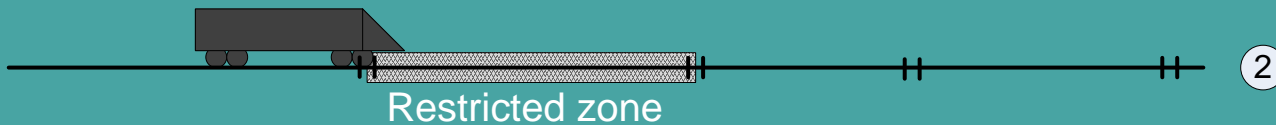
CBTC Train stops enforcing the restriction when its rear leaves the zone.

Enforcement of Restrictions

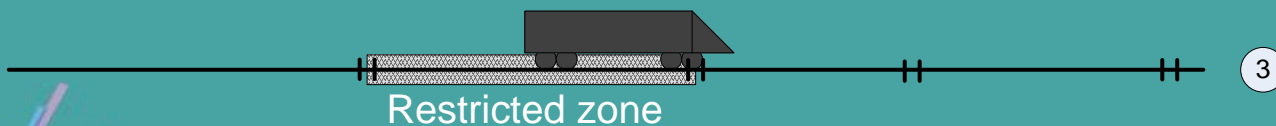
- Based on train front



CBTC Train arrives at the restricted zone. It travels at normal speed.



CBTC Train starts enforcing the restriction when its front reaches the zone.



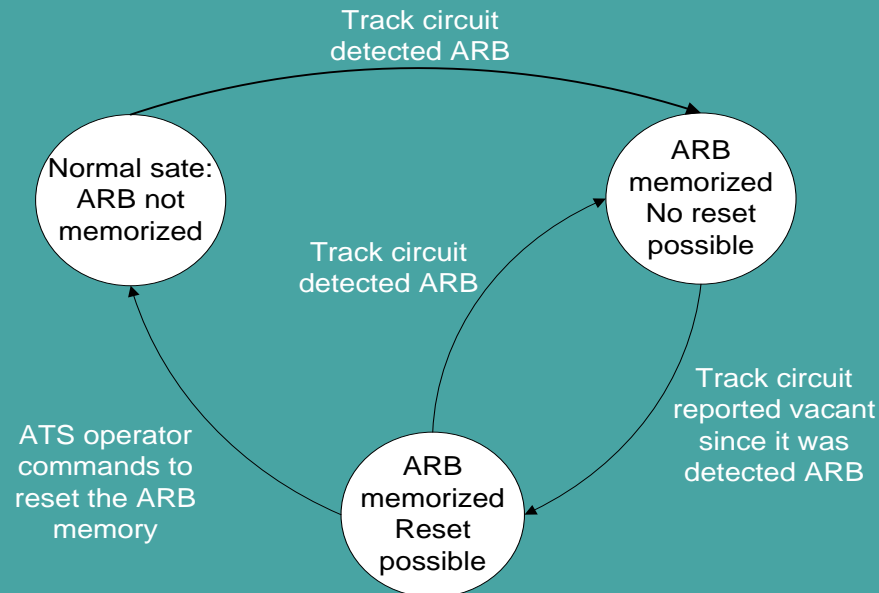
CBTC Train stops enforcing the restriction when its front leaves the zone.

Resuming normal CBTC operation

- Track Circuit repair by Maintenance
- CBTC requires repair confirmation
 - ARB: Zone Controller needs to see the track circuit is vacant
 - NRB: Zone Controller needs to see the track circuit is occupied

Resuming normal CBTC operation

- Option 1: Automatically after confirming the repair
- Option 2: After confirming the repair and after an ATS Operator command



Conclusion

1. CBTC can detect track circuit failures
2. Safety can be improved through train operation restrictions
3. Various types of operation is possible
4. Various recovery methods

Thanks / Questions / Comments

Thank you for your attention

Time for questions / comments

