Standards & Practices: Signalling & Telecommunications

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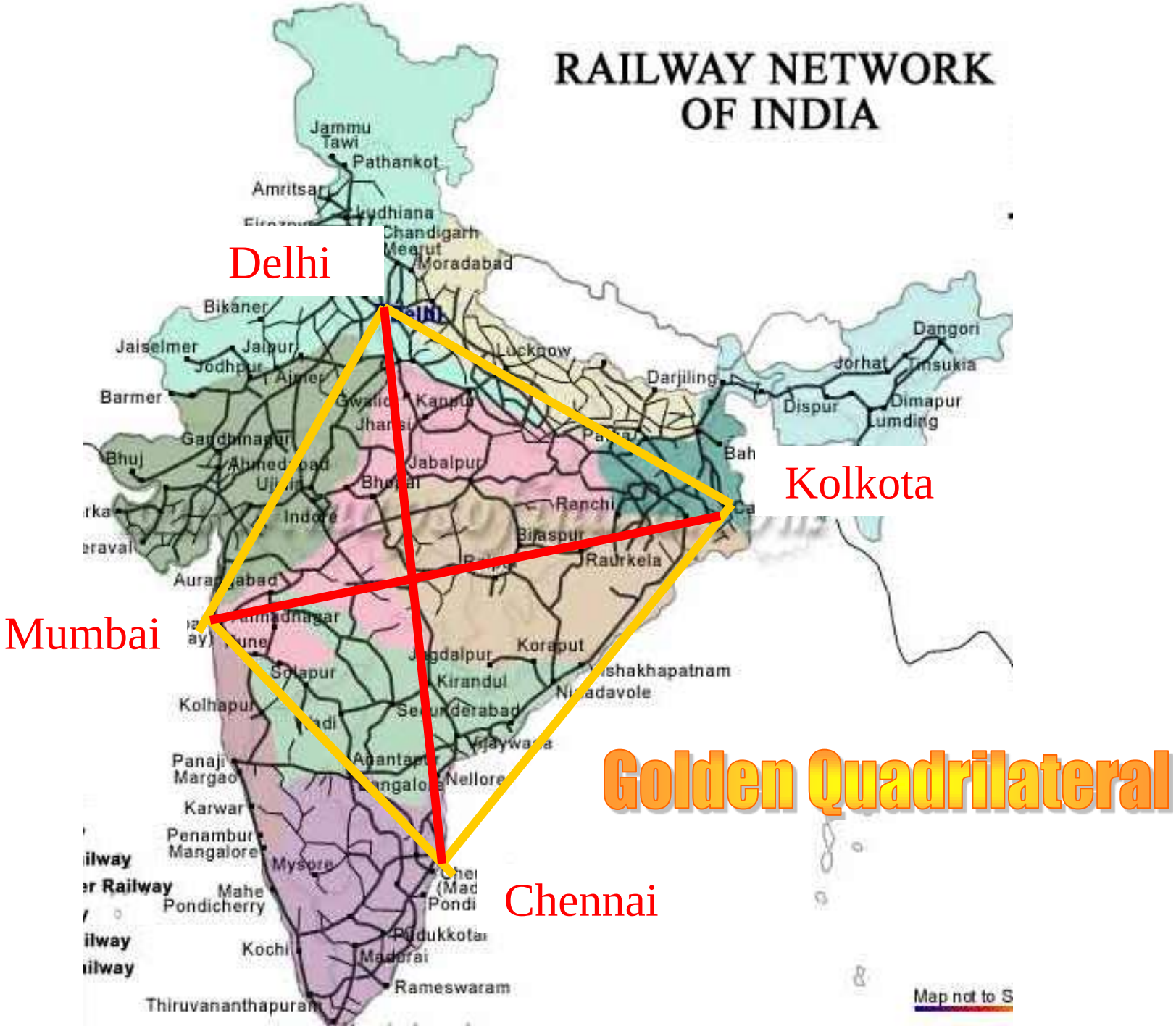
Telecommunications on Indian Railways


RAILWAY NETWORK
OF INDIA
Delhi
Kolkota
Mumbai
Chennai
Golden Quadrilateral
Jammu
Tawi
Pathankot
Amritsar
Ludhiana
Chandigarh
Meerut
Moradabad
Bikaner
Jaiselmer
Jaipur
Jodhpur
Ajmer
Barmer
Bhuj
Ahmedabad
Udaipur
Gwalior
Kanpur
Jhansi
Lucknow
Darjiling
Dangori
Jorhat
Tinsukia
Dispur
Dimapur
Lumding
Jabalpur
Bhopal
Indore
Ranchi
Bilaspur
Raurkela
Aurangabad
Ahmadnagar
Pune
Solapur
Kolhapur
Jagdalpur
Koraput
Kirandul
Visakhapatnam
Nidadavole
Secunderabad
Vijaywada
Nellore
Panaji
Margao
Karwar
Penambur
Mangalore
Mysore
Mahe
Pondicherry
Kochi
Madurai
Rameswaram
Thiruvananthapuram
Map not to S

To err is human

To safeguard against that error is Signalling

Why Signalling for Rail Transport ?

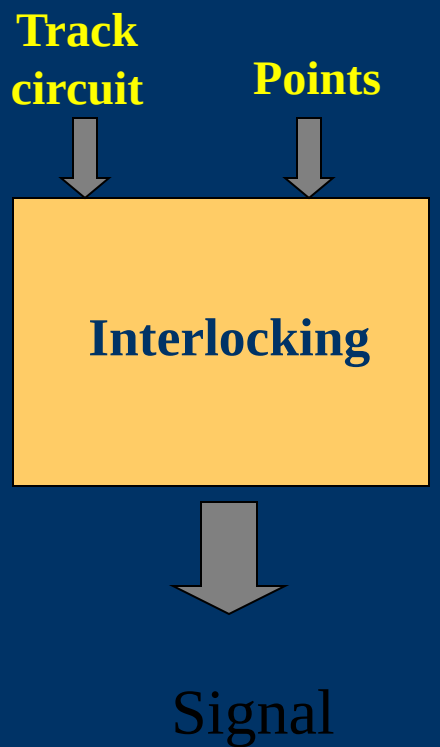
- **Safety in Rail Transport**
  - **Safety on ground**
  - **Safety on-board**
- **Increase line capacity : *run more trains on the same tracks***
- **Operational Benefits through Advanced Signalling**

Railway Signalling Systems are required to ensure safe train operations by Reducing human dependence & to make Optimum use of existing line capacity

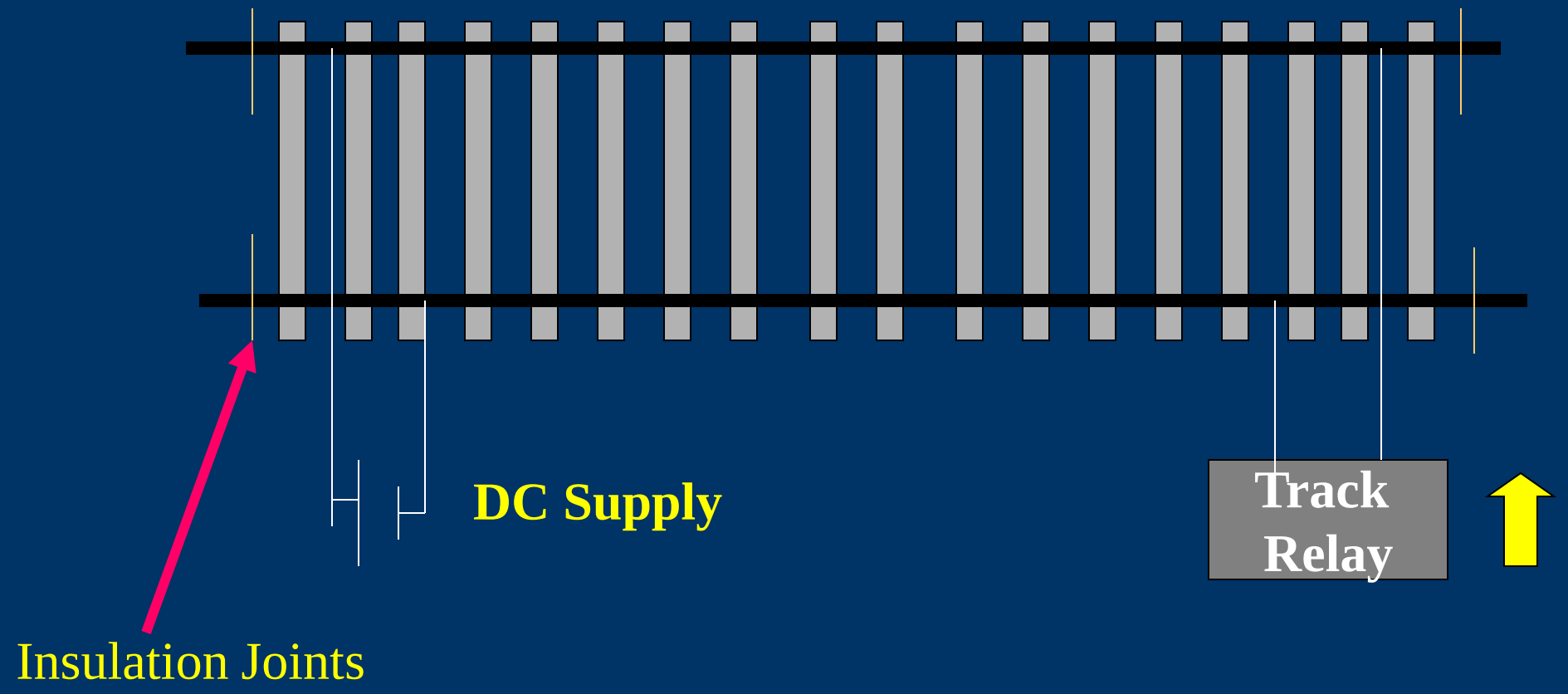
Design philosophy of Rail Systems: *Failsafe*

- **All signalling systems, equipments and components have to be *fail safe.***

- **Failure of any signalling equipment or component should either result in signal displaying most restrictive information i.e. DANGER or impose a restriction on the movement of trains.**


Track circuit
Points
Interlocking
Signal

Track Circuit : An electric circuit formed along the running rails. Function is to detect **presence** or **absence** of a train on that portion of track.



Track Not occupied : Track Relay is Energised

Track Circuit : An electric circuit formed along the running rails. Function is to detect **presence** or **absence** of a train on that portion of track.

Track Not occupied : Track Relay is Energised

TRAIN DETECTION

TRACK CIRCUIT

AXLE COUNTER

DC

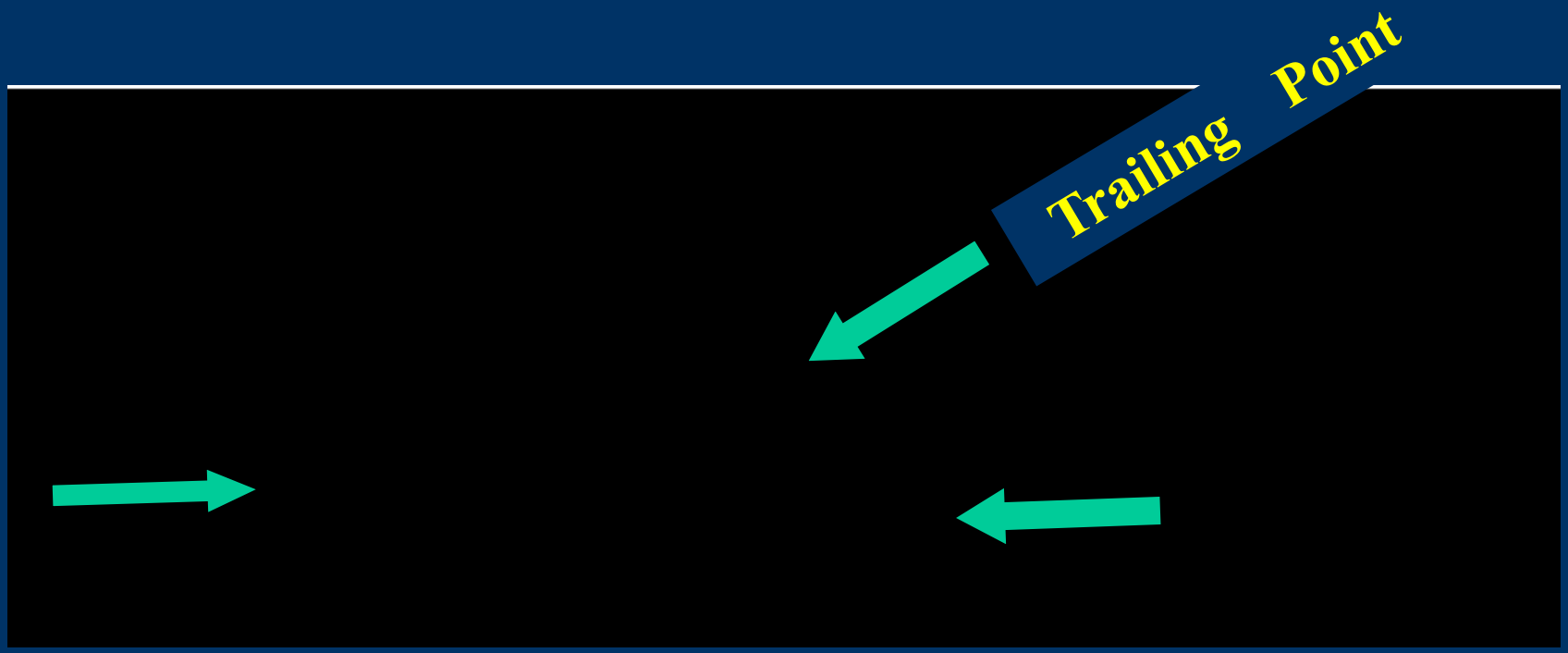
AFTC (JOINTLESS)

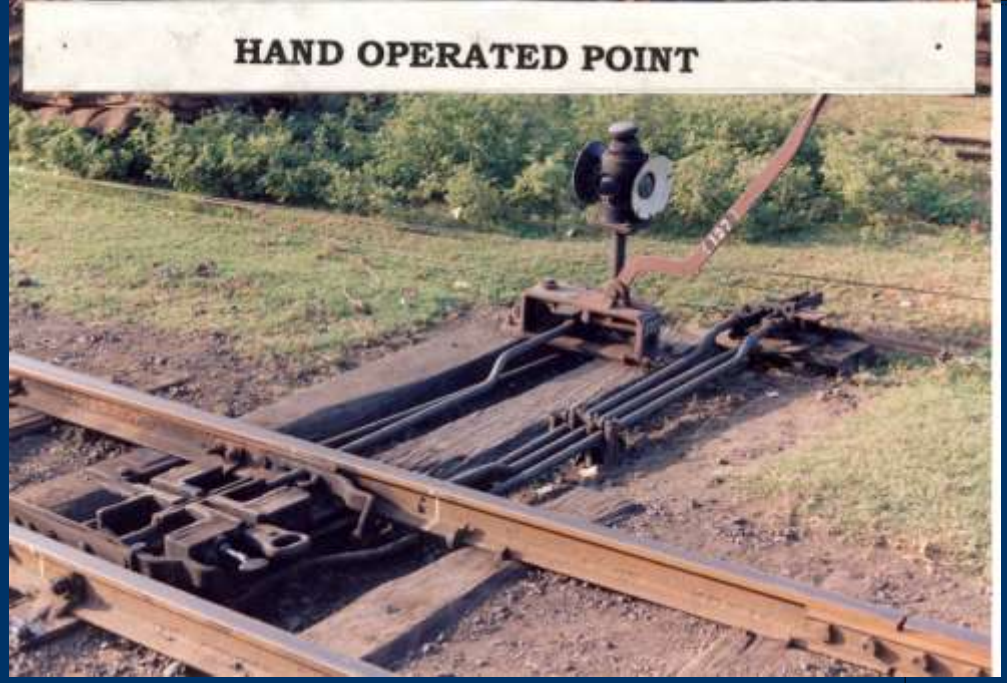
Audio Frequency Track Circuits

Counts no. of Axles

POINTS : A Mechanism provided on the track to facilitate diversion of trains from one route to another.

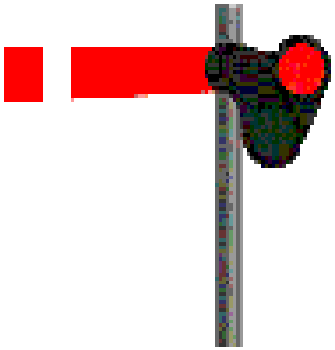
(Our Engines do not have steering wheel as available in motor cars)



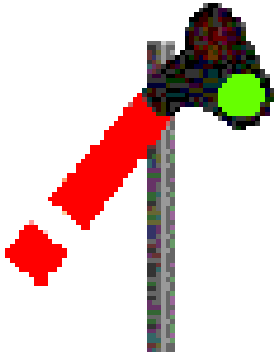


Different Mechanisms for operating Points

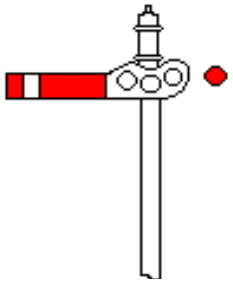
Semaphore Signalling



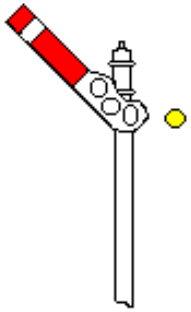
STOP



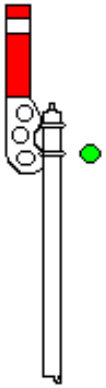
PROCEED



STOP

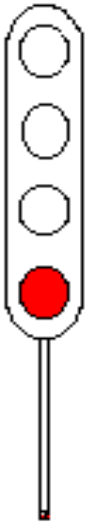


CAUTION



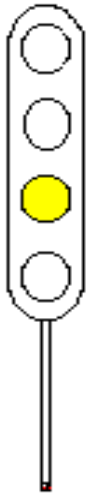
PROCEED

Colour Light Signalling (Multiple-Aspect)



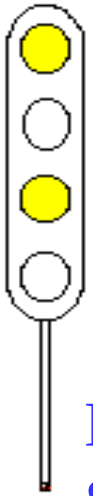
STOP

STOP



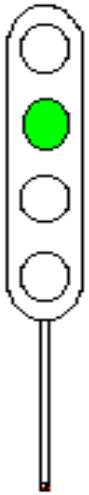
CAUTION

Be prepared to stop at next Signal



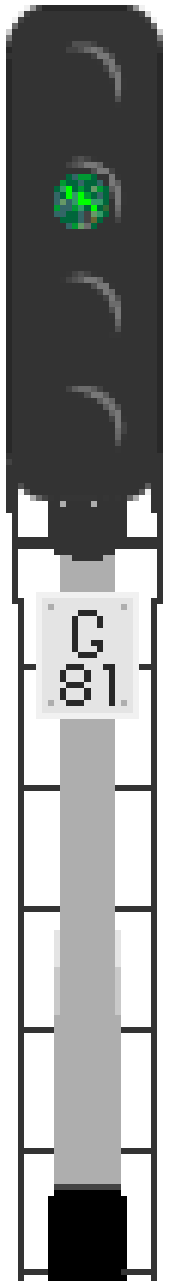
ATTENTION

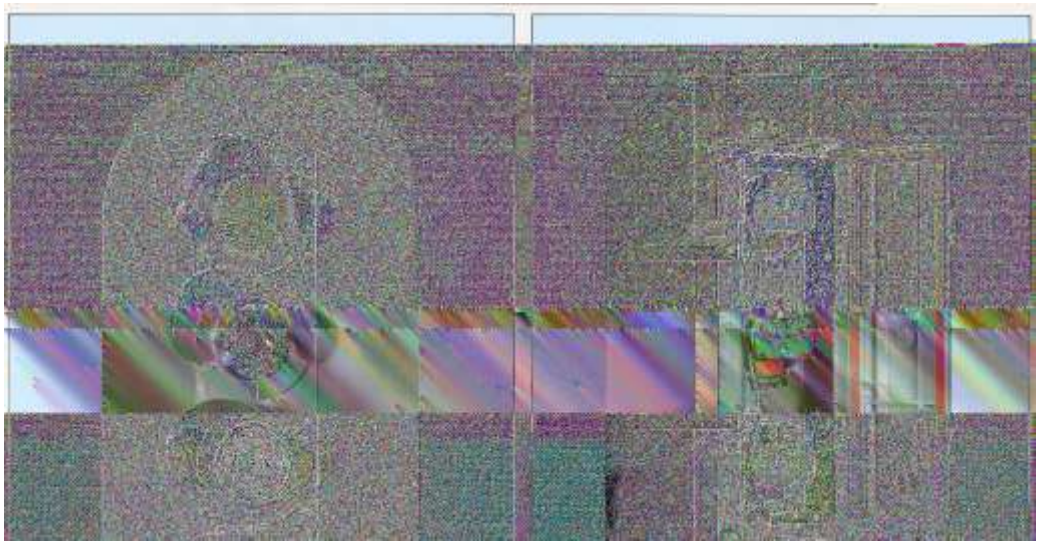
Be prepared to Pass next Signal at slow speed



PROCEED

Proceed with full permitted speed





LED Signals

(Light Emitting Diode)

ADVANTAGE; CURRENT CONSUMTION LOW

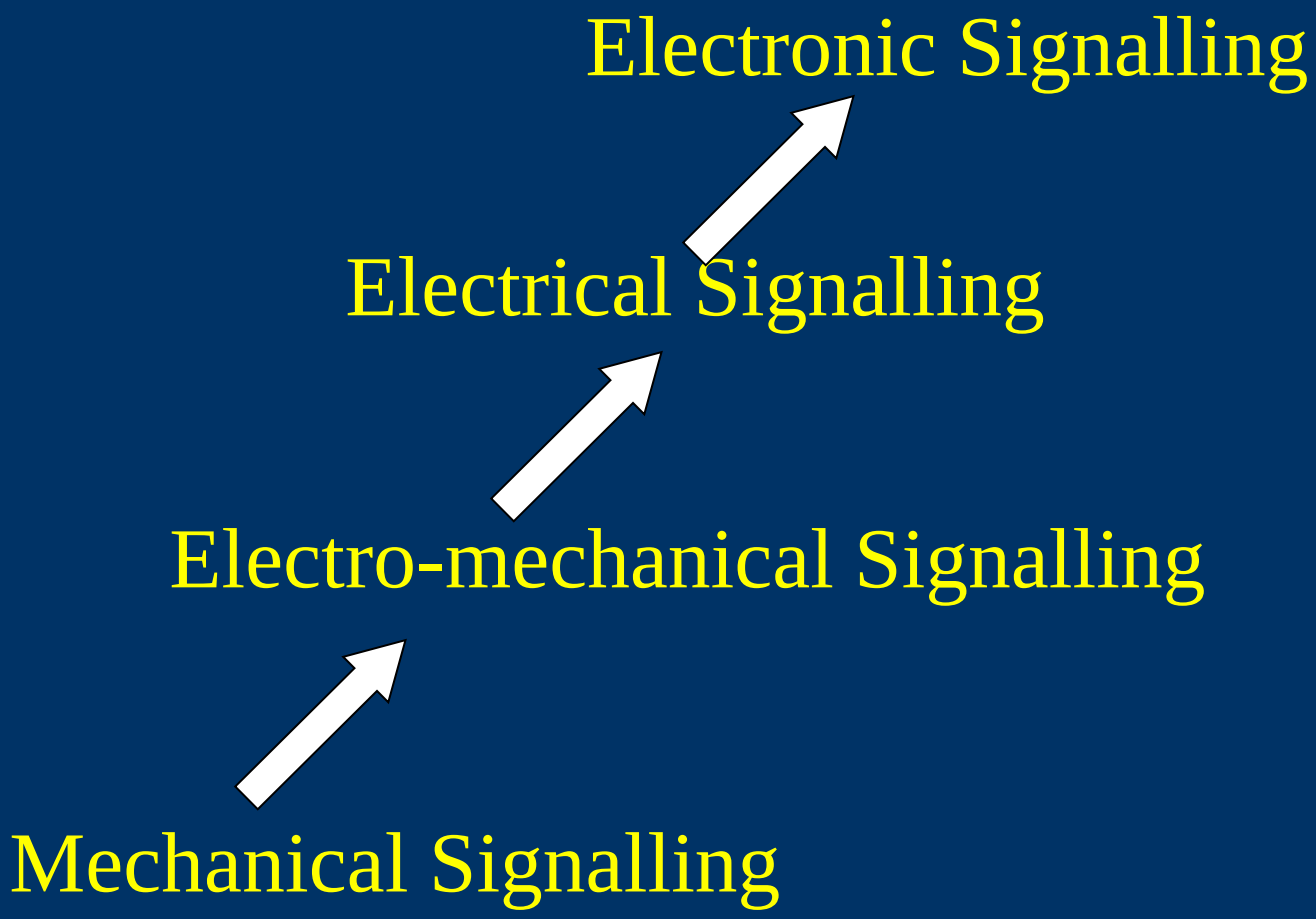
(110mA COMPARED TO 300 mA in Signal Bulbs)

ELIMINATION OF BULB FUSING

HIGHER VISIBILITY

So far about 3000 signal aspects have been provided with LED based signals.

Development of Signalling



Operating Panel

SSI is as interlocking system which employs micro processors and software for interlocking functions.

Advantage of smaller space, power, cabling and maintenance requirements besides fast software based upgradation facility & flexibility to meet changes in yard layouts.

SSIs provide high level of reliability, availability and fail safety.

Computer based Operating Console

(Solid State Interlocking)

Signalling on Indian Railways

Installation	(in units) As on 31.12.05
Token less Block Working (No. of Block Sections)	1,380
Automatic Block Signalling (Track kms.)	3,571
Multiple Aspect Colour Light Signalling (No. of stations)	3,112
Panel Interlocking (No. of stations)	2740
Route Relay Interlocking (No. of stations)	204
Solid State Interlocking (No. of stations)	91

Interlocking Principle

CHECK

- Complete route for reception of train is unoccupied
- All points are correctly set & locked
- All Conflicting signals are at Danger Position(RED)
- Level Crossing gates (if any) are closed

Till Then

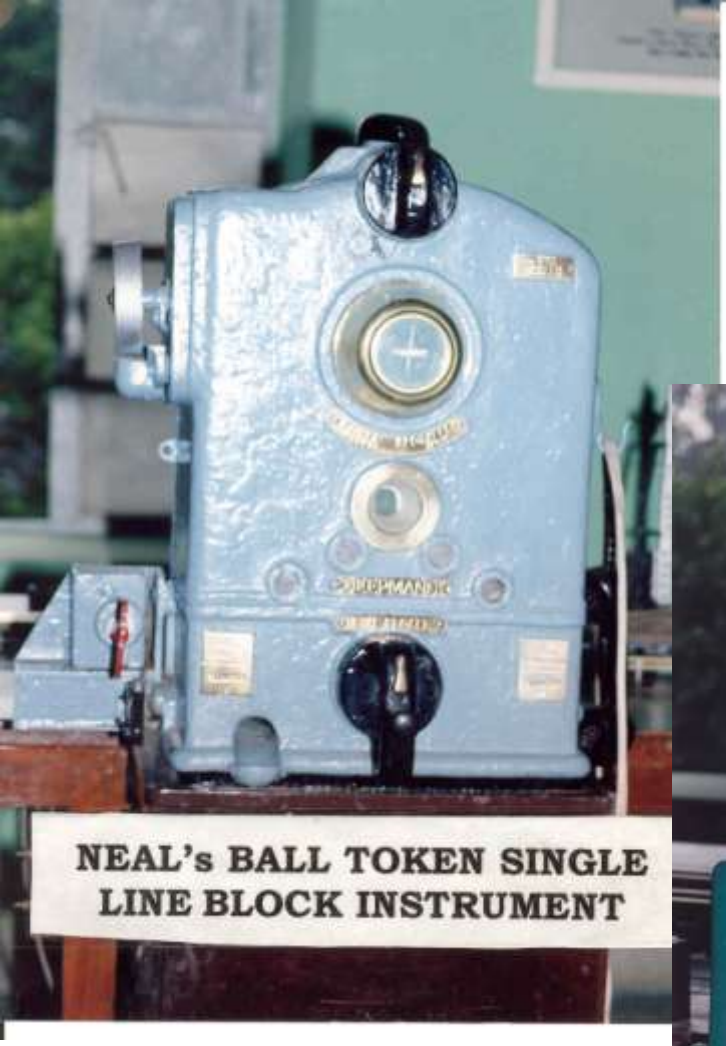
All Clear

10.2 Requirements for different standard of Interlocking

Type of Equipment /arrangement	Reudimentary Std. 0	Std. I	Std. II	Std. III
1. Max. speed over the Facing Point unrestricted on the main line in kmph	15	50	75	maximum permissible
2. Point equiipment				
i) Setting	Local operation	Location operation	Local operation	Central operation
ii) Locking	Padlocking	Key lock	Hand plunger	Facing point lock or point machine
iii)Route holding	----------	No arrangement	---------- -	Lock bar or track circuits
iv)Detection	No required	Required	Required	Required
3)Isolation	-----do ------ --	Not Required	-------do----- ---	--------do------
4)Interlocking	Indirect	Indirect	Indirect	Direct

10.2 Requirements for different standard of Interlocking

Type of Equipment /arrangement	Reudimentary Std. 0 --	Std. I	Std. II ---	Std. III
4)Interlocking	Indirect	Indirect	Indirect	Direct
5)Signals LQ	Outer common Home	Outer bracketed home	Outer bracketed home starter warner	Outer bracketed home starter warner Advanced starter (if necessary)
MAUQ	Distant home starter		Distant Home starter	Distant home starter [redacted] Advance starter (if necessary)



NEAL's BALL TOKEN SINGLE LINE BLOCK INSTRUMENT

DOUBLE LINE BLOCK INSTRUMENT

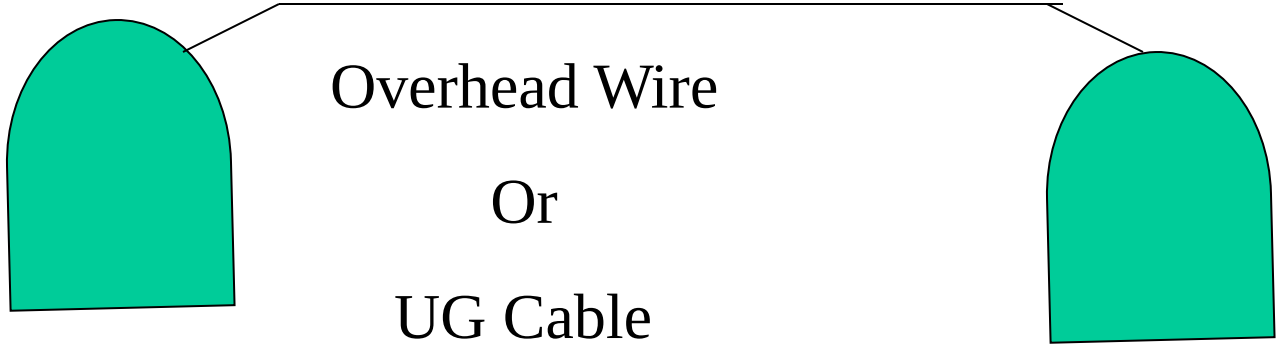
NON CO-OPERATIVE TOKENLESS SINGLE LINE BLOCK INSTRUMENT

Block Instruments: To ensure only one train moves between two stations at a time

ABSOLUTE BLOCK SYSTEM

Station A

Station B



Overhead Wire

Or

UG Cable

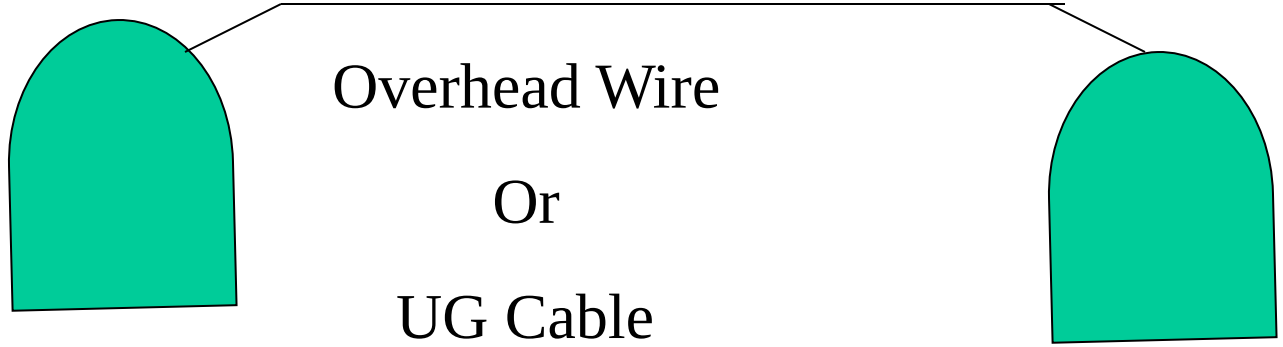
Block Instrument

Block Instrument

ABSOLUTE BLOCK SYSTEM

Station A

Station B



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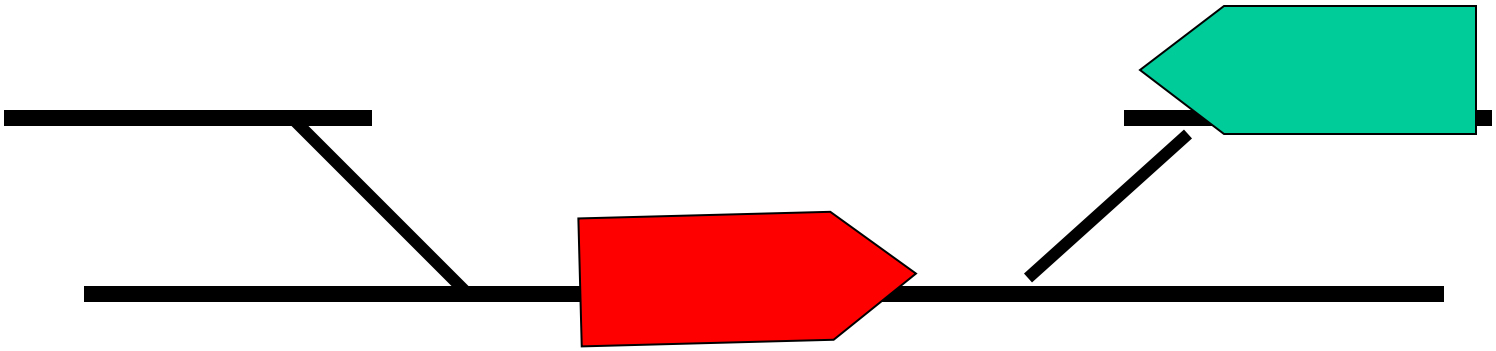
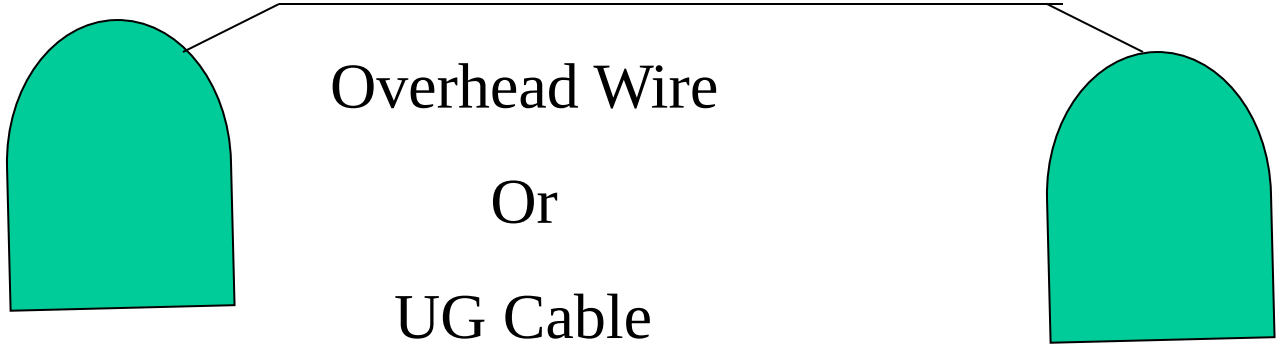
Station B





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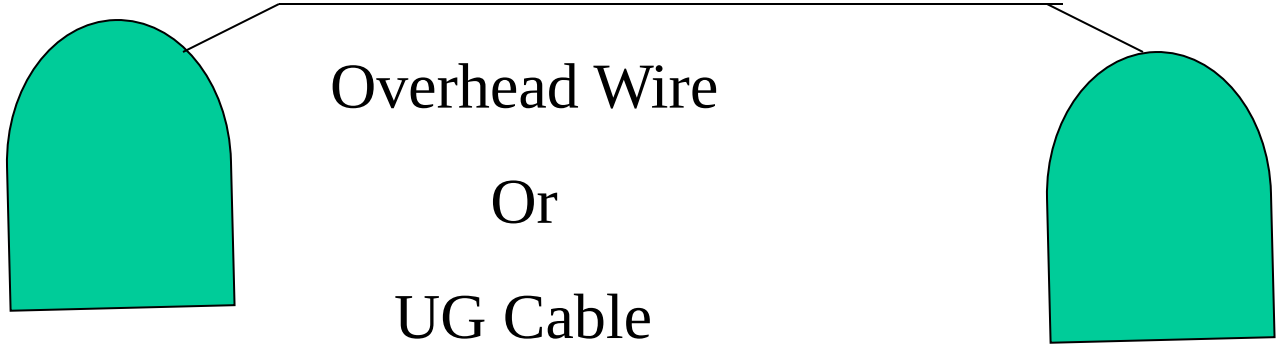

Overhead Wire

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Block Instrument

Block Instrument

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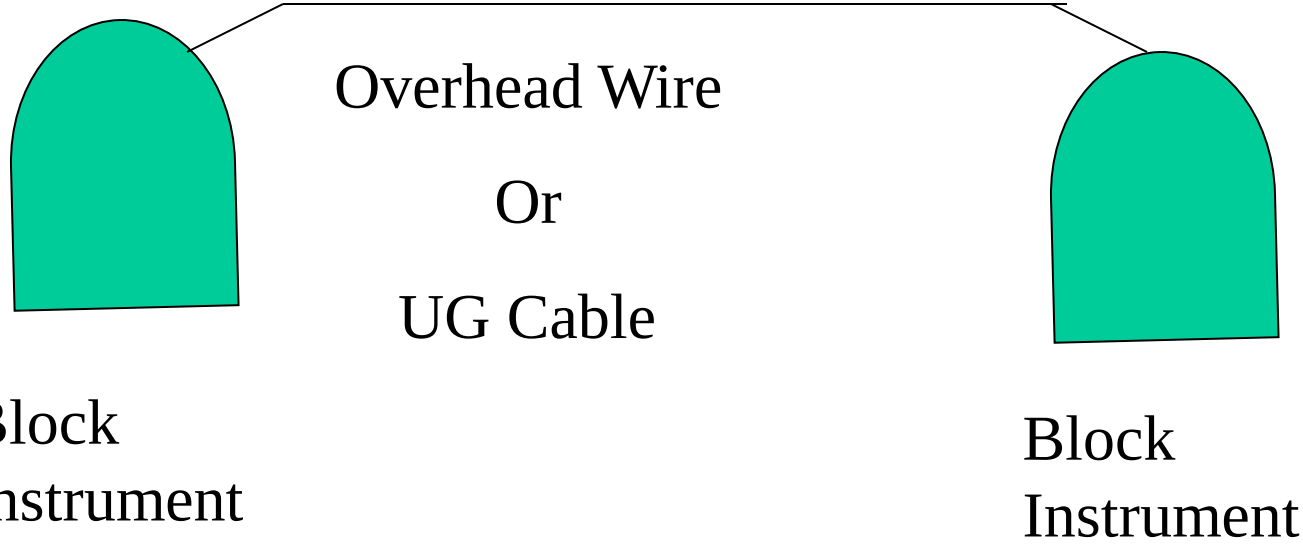
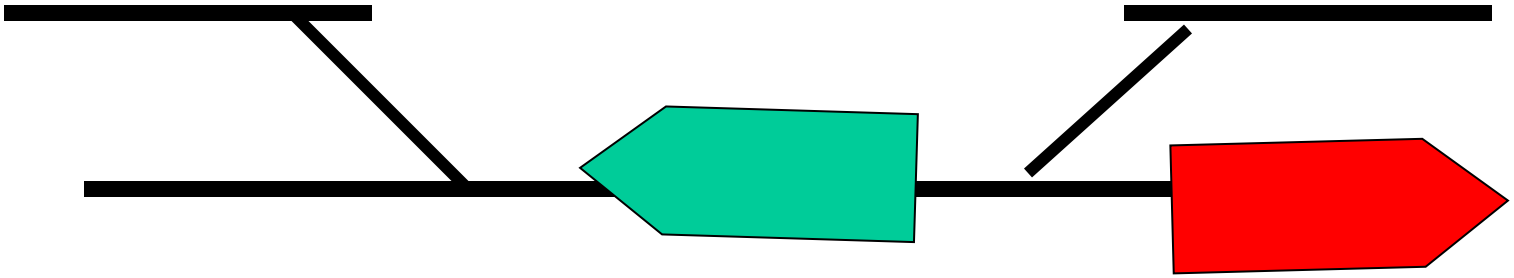
Station B

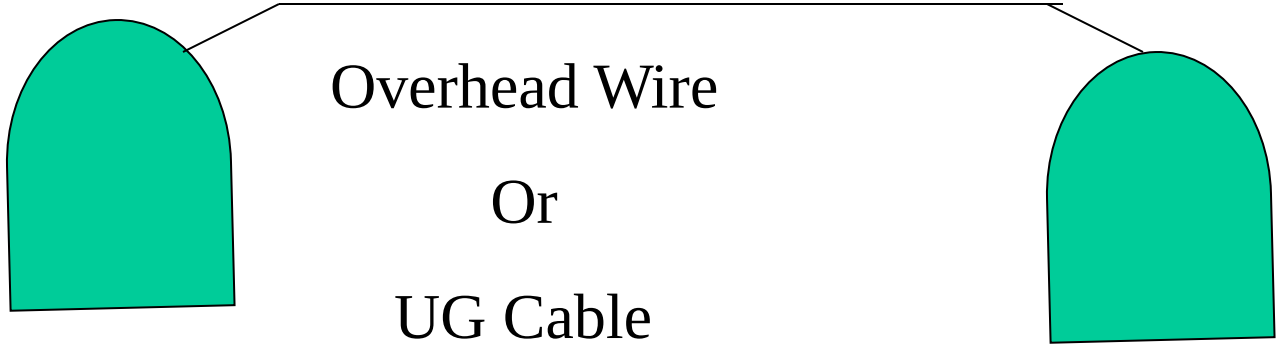


ABSOLUTE BLOCK SYSTEM

Station A

Station B





Overhead Wire

Or

UG Cable

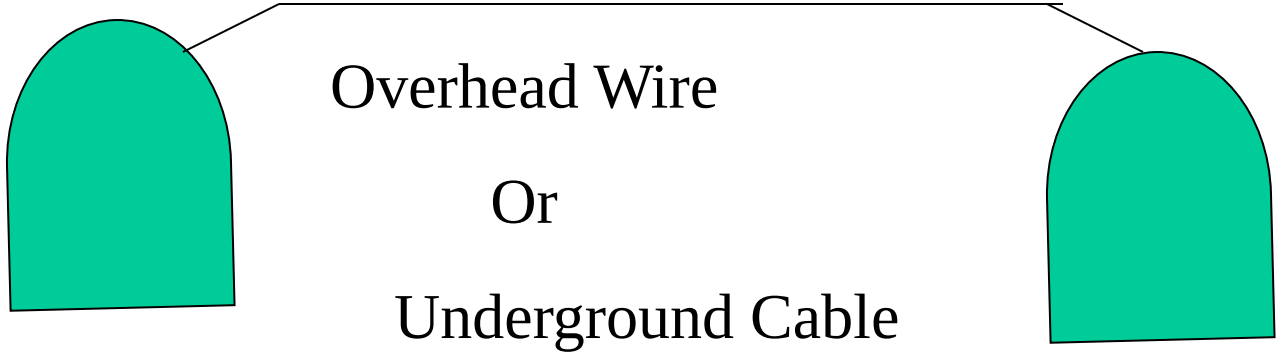
Block Instrument

Block Instrument

ABSOLUTE BLOCK SYSTEM

Station A

Station B



Overhead Wire

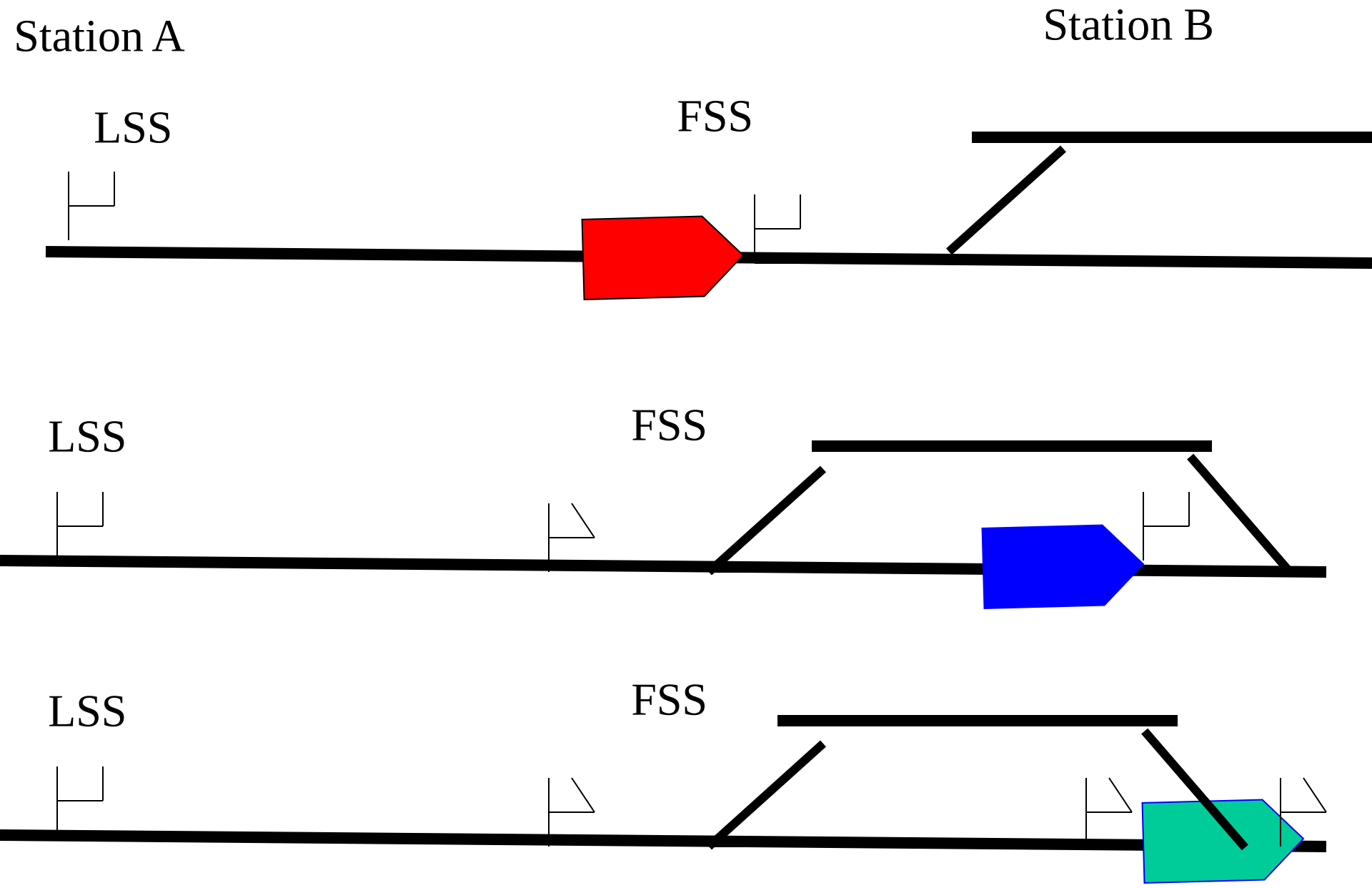
Or

Underground Cable

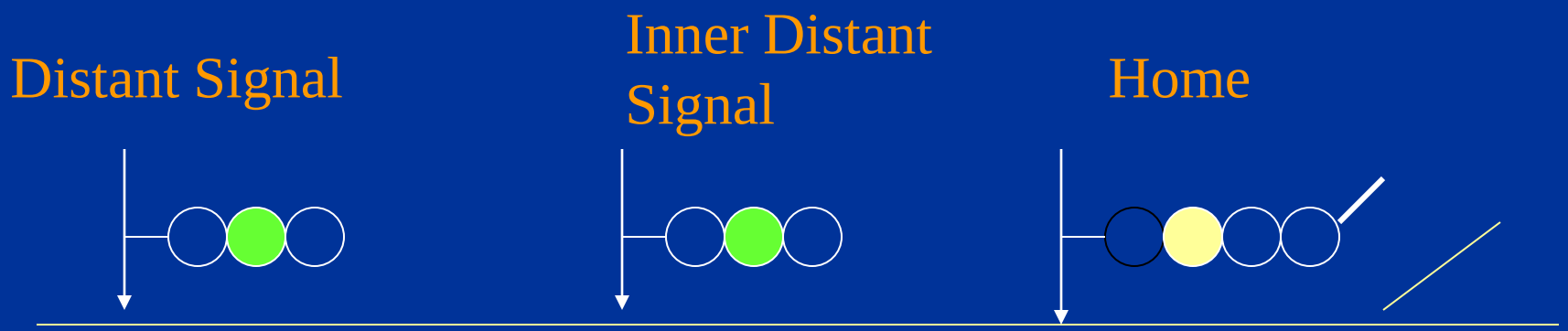
Block Instrument

Block Instrument

ABSOLUTE BLOCK SYSTEM



Double Distant Signal

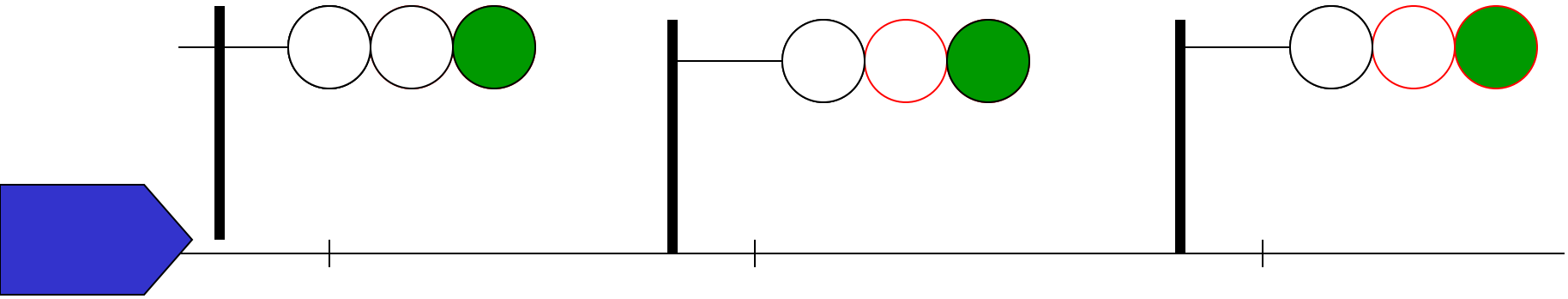


YY	Y	R
	YY	Y with Route
G	G	Y
G	G	YY
G	G	G

Distant Signal: YY : Stopping on Main Line; Or Being Recd on Loop Line

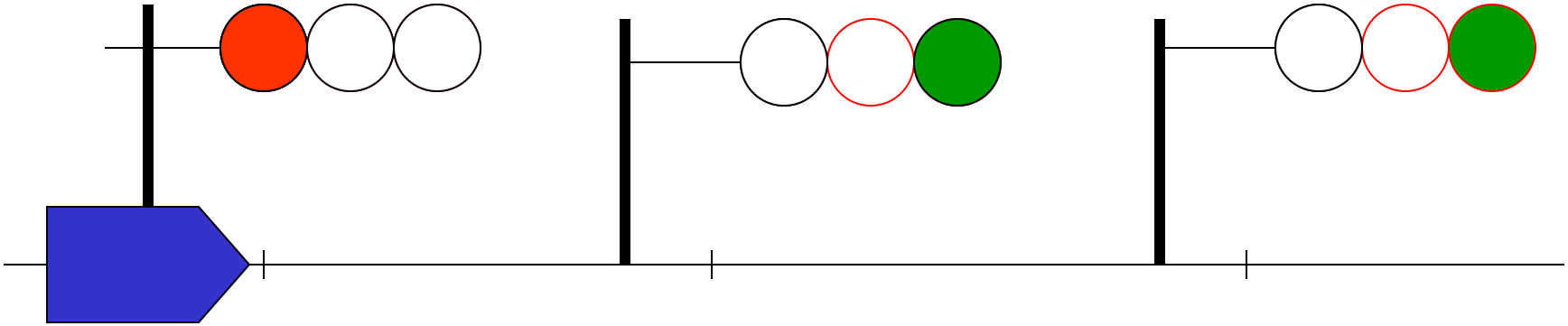
Distant Signal: G: Being Received on Main Line

AUTOMATIC SIGNALLNG



Signal Clearance automatically done by Train Movements

Automatic Signalling



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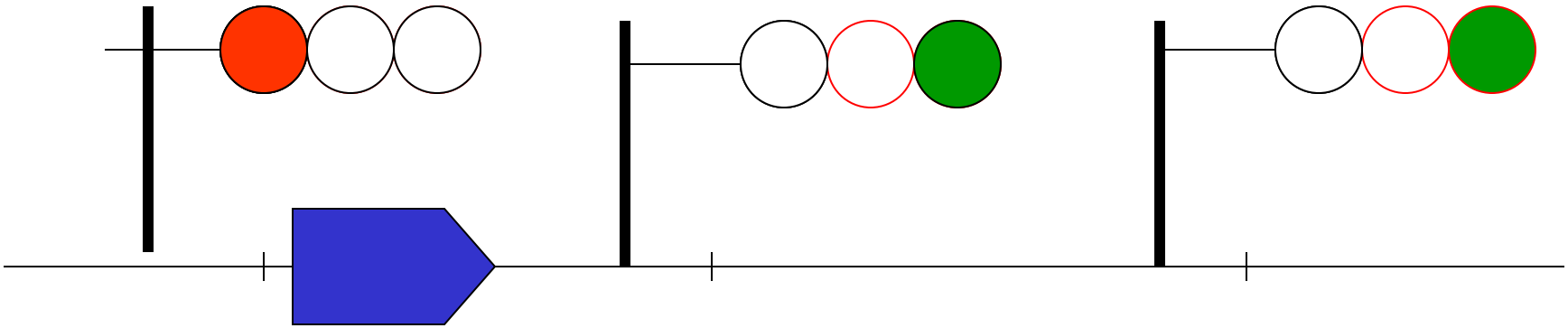

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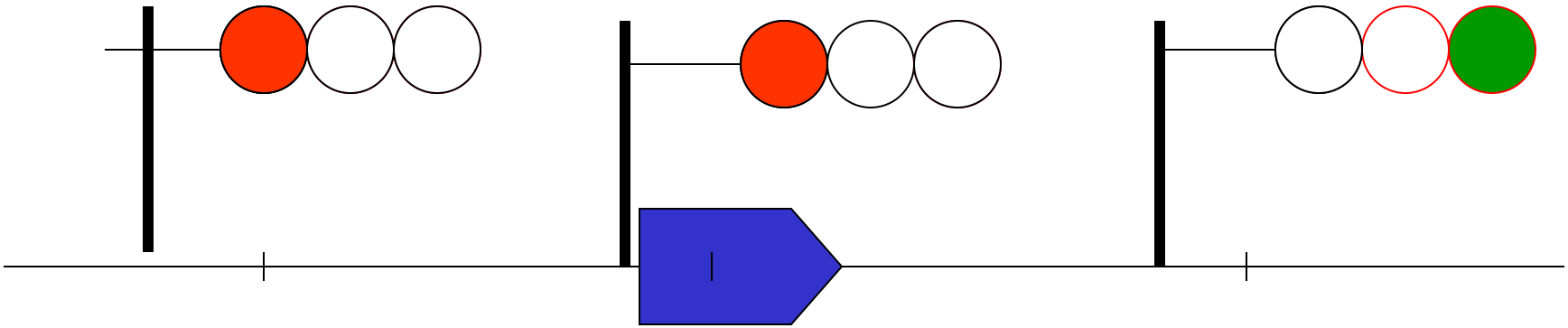

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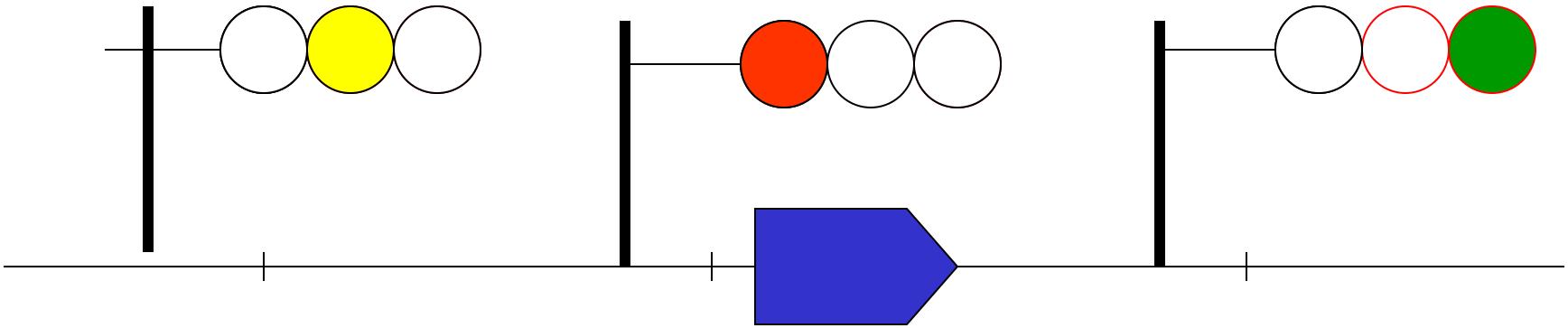

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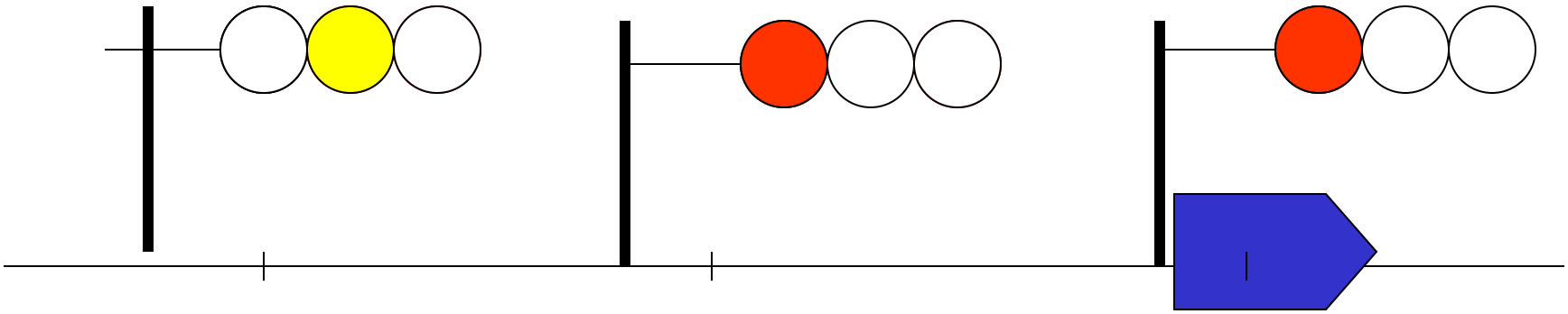

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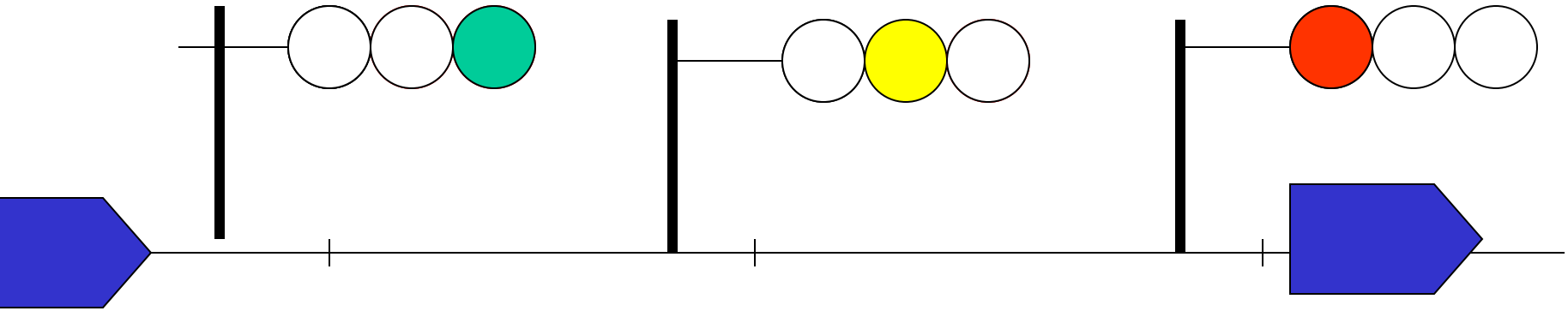
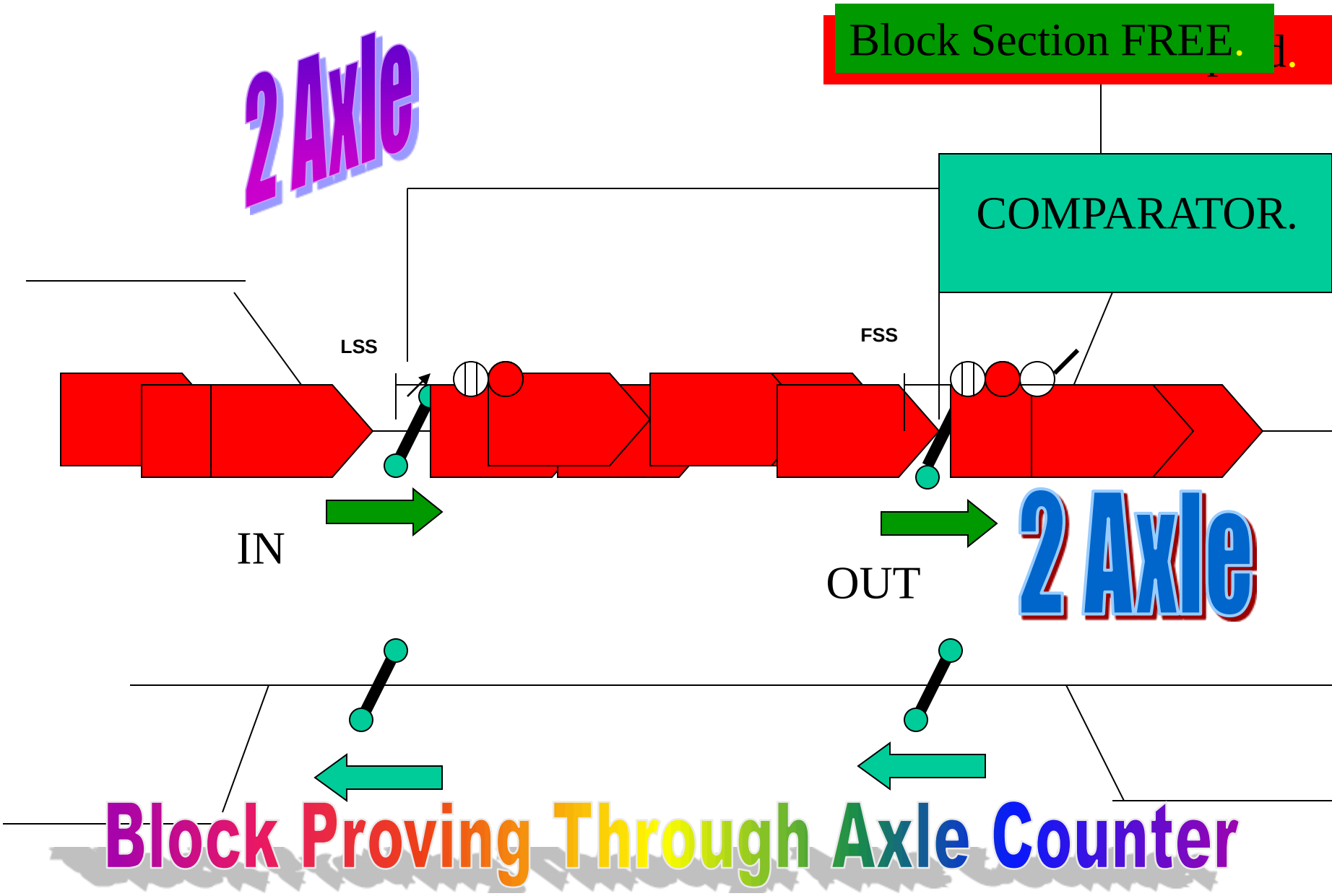


Signal Clearance automatically done by Train Movements

Automatic Signalling

Available on Suburban Sections



Block Proving Through Axle Counter

Provides a check of complete arrival of the train and proves block clearance automatically. 488 block sections on IR have so far been covered.

SAFETY AT LEVEL CROSSINGS

Level Crossings : 37345

Manned : 16,607

Un manned: 20,738

Telephones: 15572

Interlocked : 7428

TAWD: 7

a major concern

UNMANNED LEVEL CROSSINGS:-

TRAIN ACTUATED WARNING DEVICE (TAWD)

⇒Audio-visual warning of approaching train to road users

⇒Trials conducted in the field.

⇒Such devices are being provided on 100 Level Crossings in first phase

Alarm Systems at LC gates

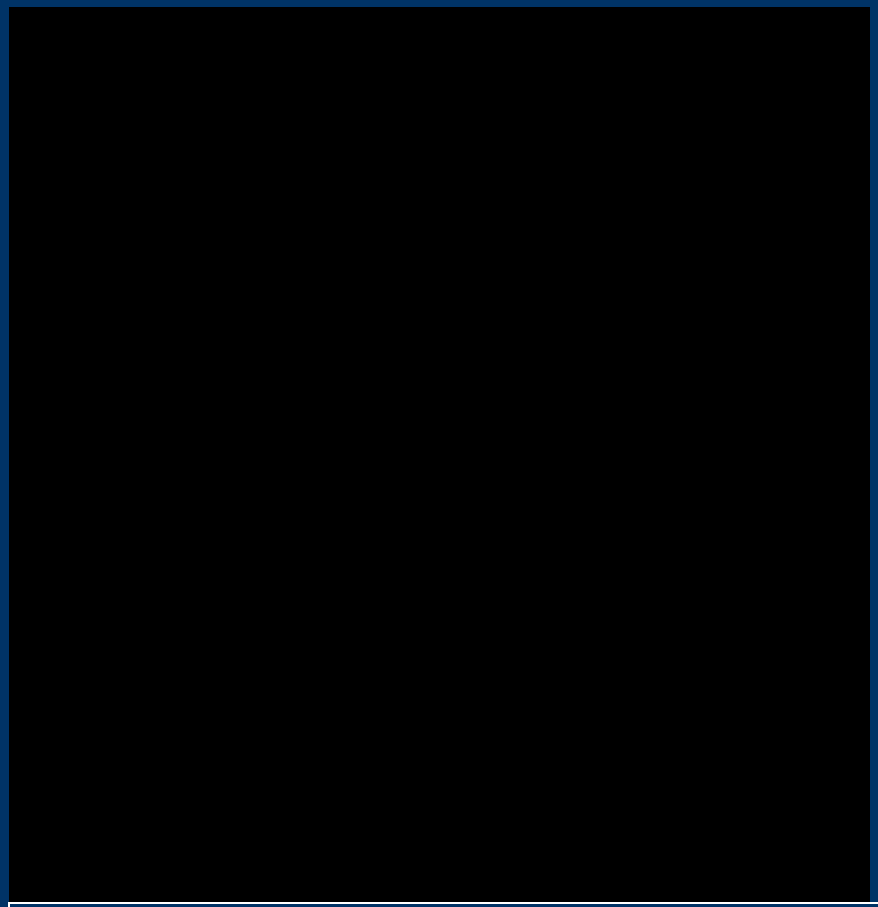
USING OPTICAL OBSTRUCTION

(The Japanese Way)

Reducing Human Dependence through Advanced Signalling

ATP: Automatic Train Protection

ATP & Mobile Communication, Sweden



Cab Signalling with ATP (Shinkansen, Japan)

Suburban Trains,

Mumbai

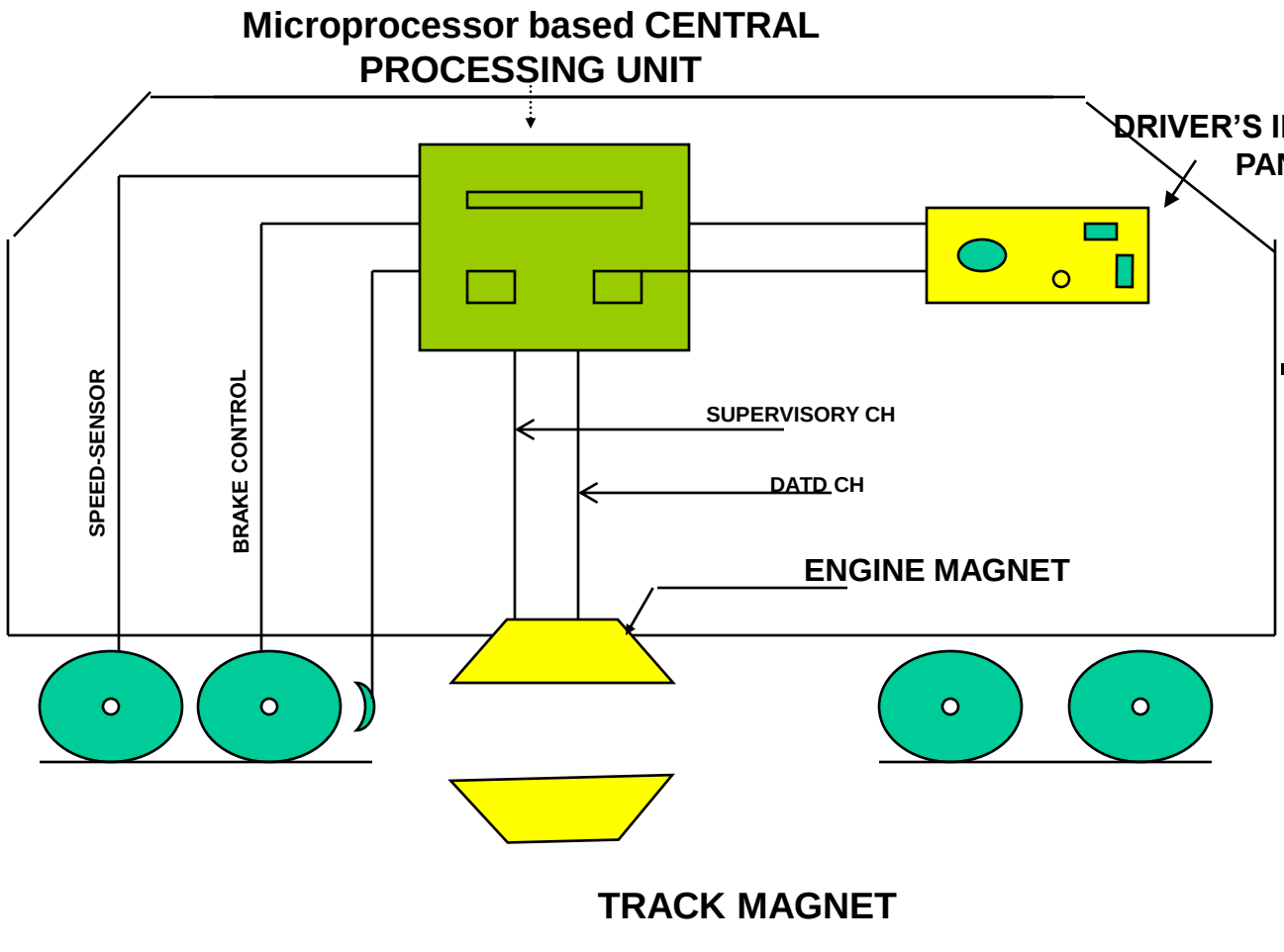
Auxiliary Warning System(AWS)

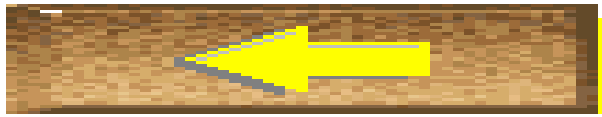
- Applies Brakes automatically in case Driver disregards a Red Signal
- Regulates Train Speed to 15 KMPH on Yellow Aspect
- Controls Train speed on RED signal

(Available on WR (1987) & CR Suburban Sections on Mumbai).

ATP : Automatic Train Protection

Auxiliary Warning System





Opto coupler

Transmits Signal Aspect indications

For Safety in Train Operations

ATP: Automatic Train Protection

is a MUST

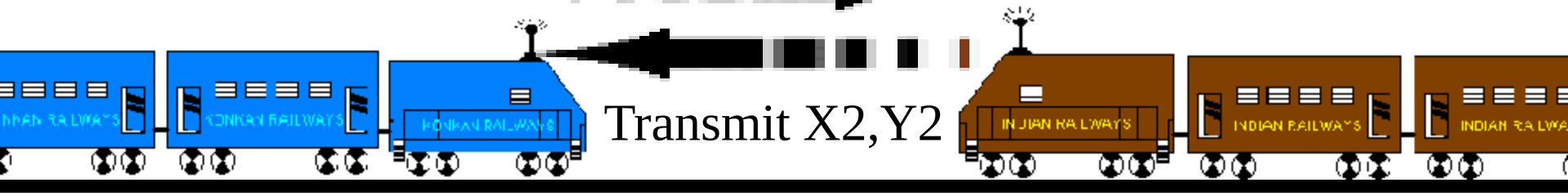
ACD : Anti Collision Device
(developed by Konkan Railway)

- ACD is a software based equipment comprising of
  - A microprocessor unit
  - A radio-modem for encrypted digital communication
  - A GPS Receiver : to determine the position of a train from GPS satellites.

ACD

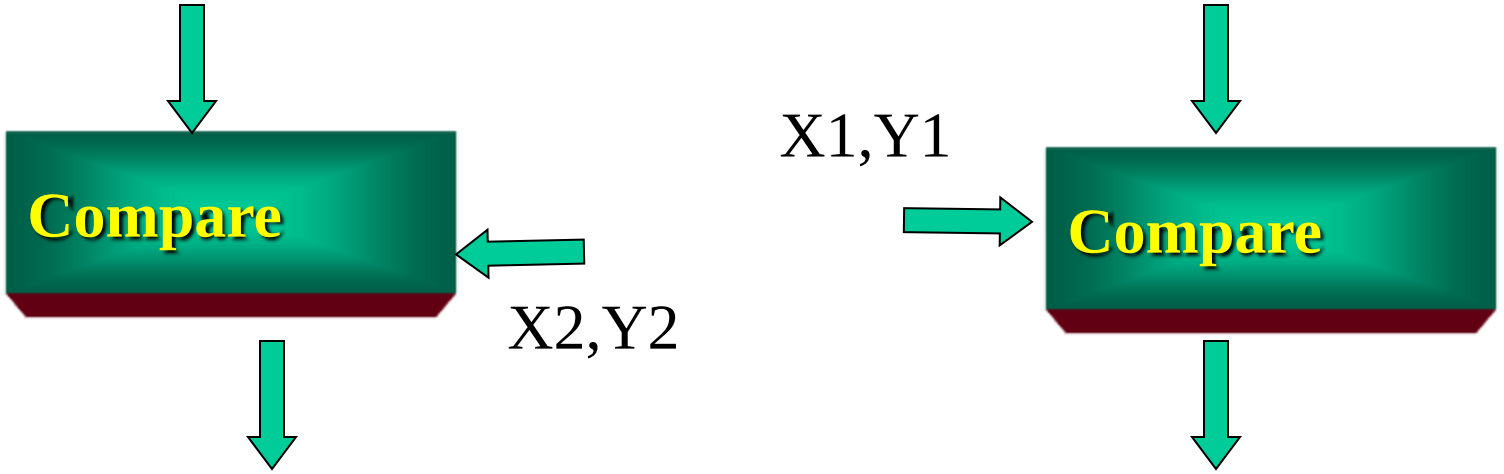
Transmit X1,Y1

And Direction



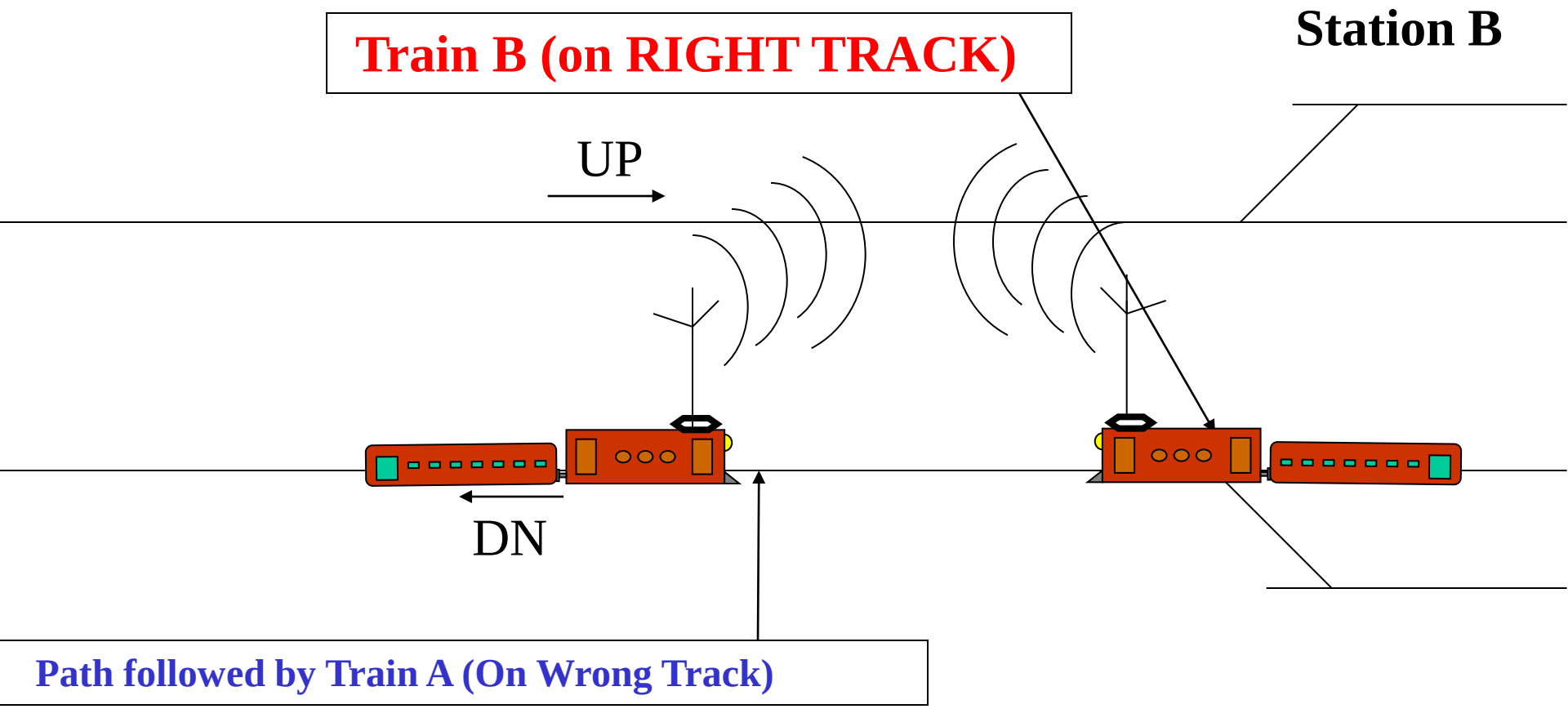
X1,Y1(GPS coordinates)

X2,Y2 (GPS coordinates)

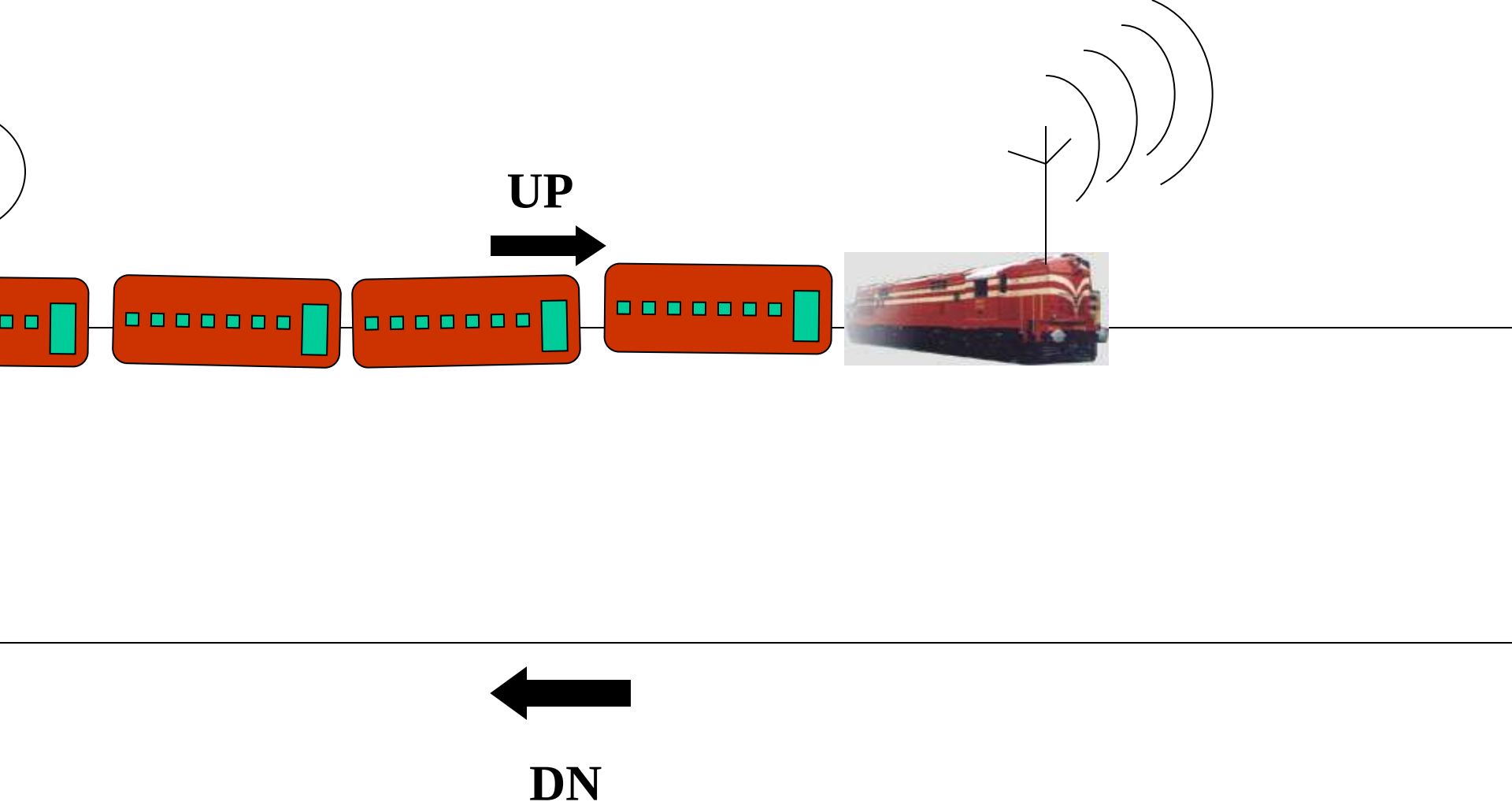


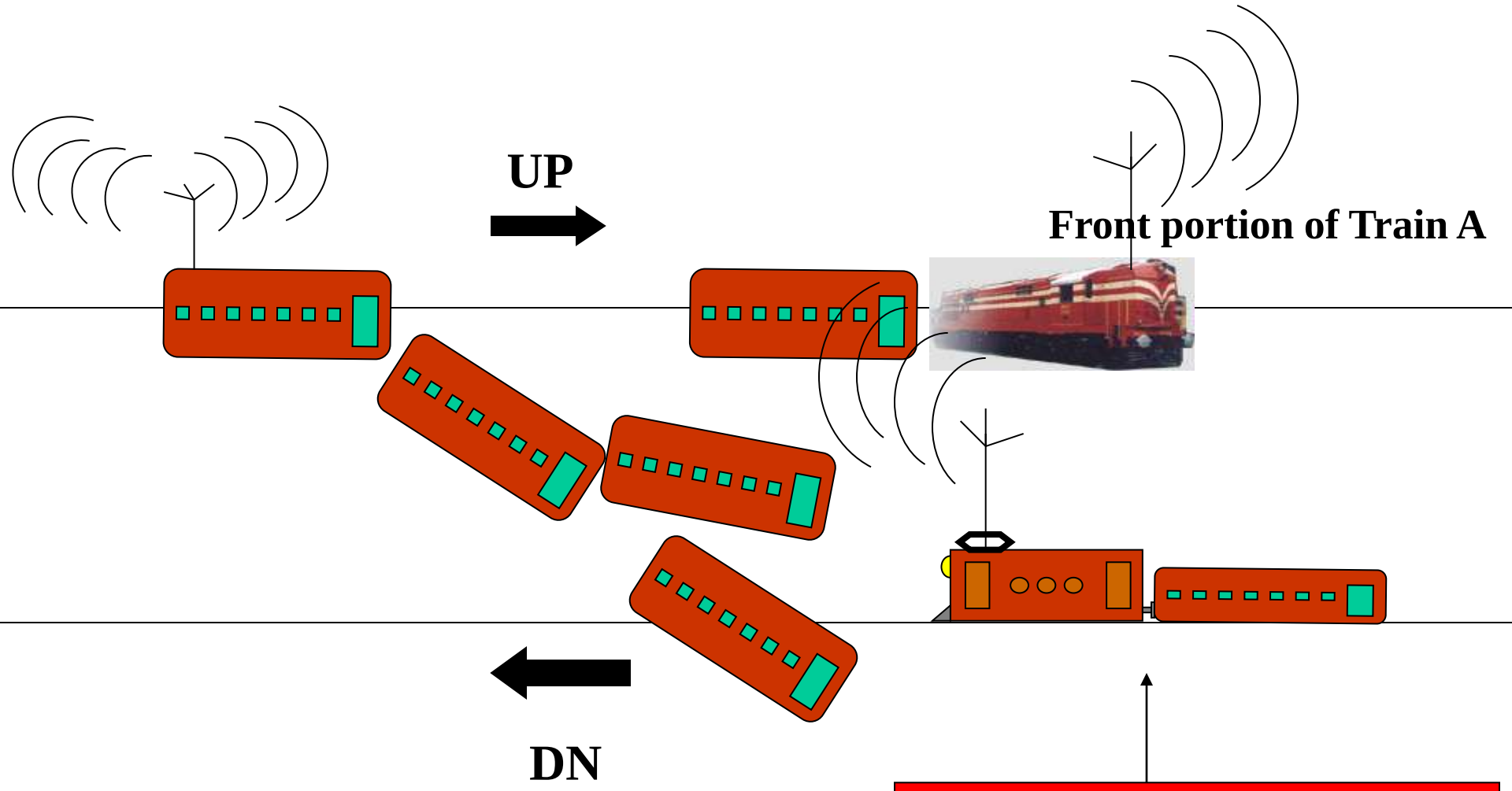
If Inter distance is less than 3 Km apply brakes.

Preventing ‘Head-on Collision’



‘Loco ACDs’ of both the trains ‘Approaching’ each other with the same ‘Track ID’ would cause application of brakes

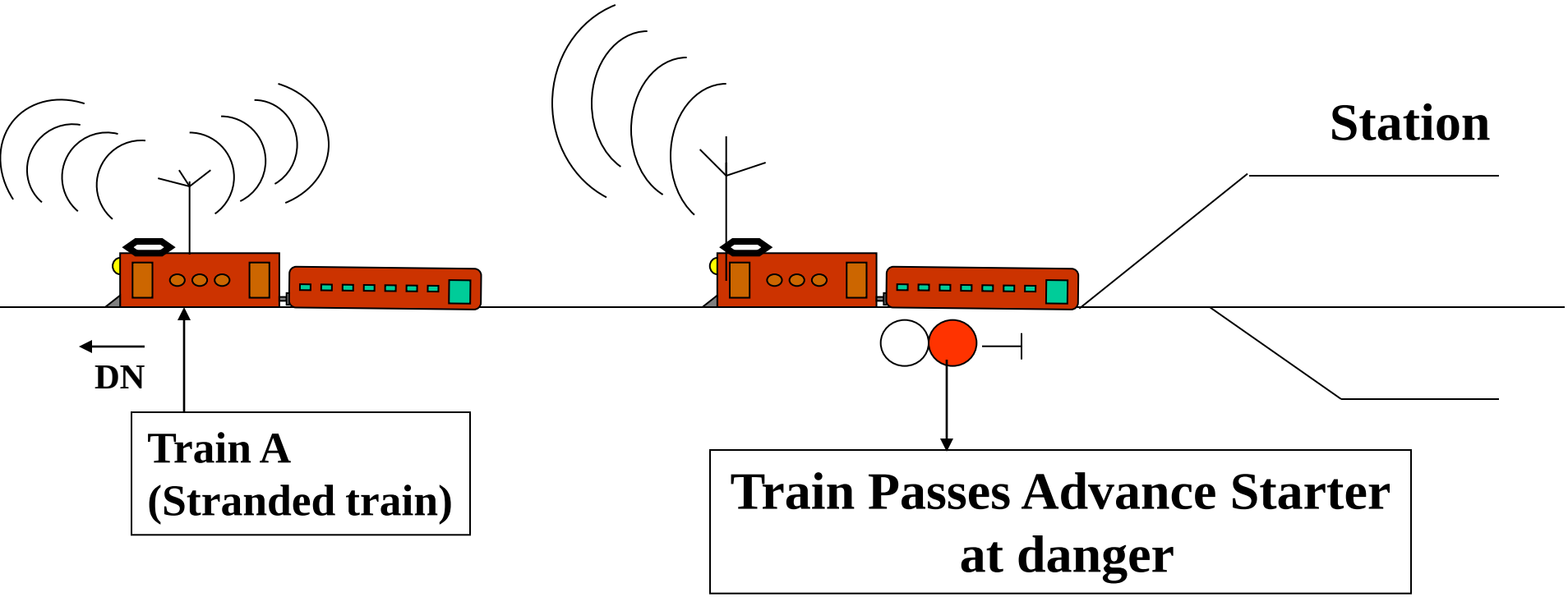

UP
DN



Both ‘Guard’ & ‘Loco’ ACDs of Train A would generate ‘Auto-SOS’ on detection of ‘Train Parting’

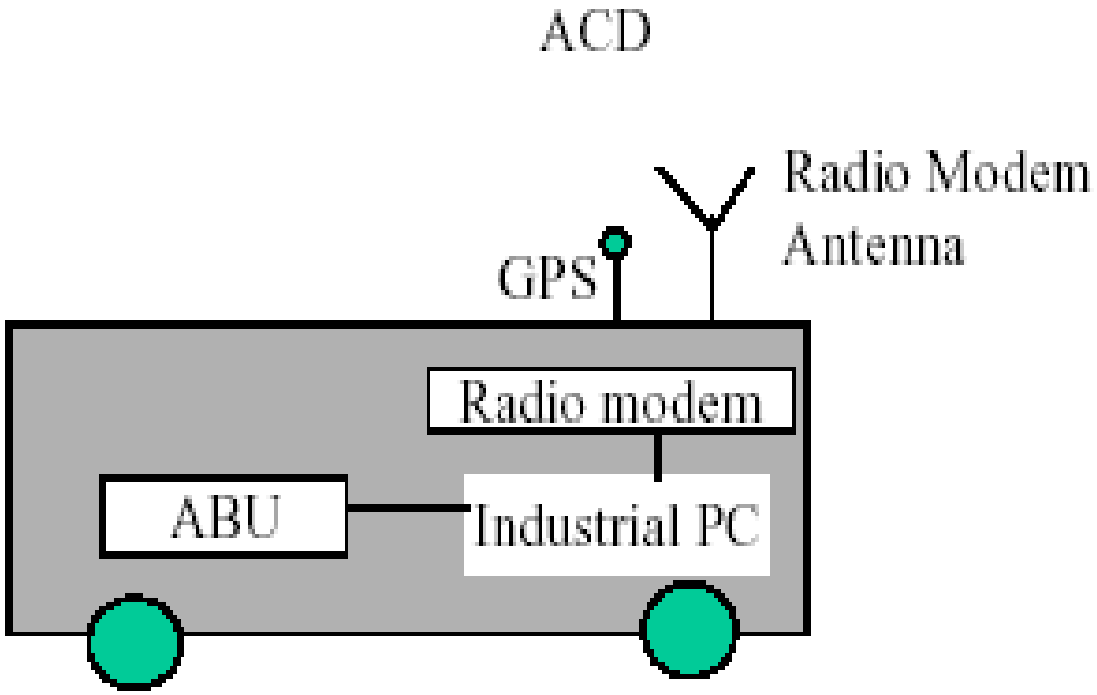
Loco ACD of Train B would apply brakes, on receipt of ‘Auto-SOS’ from Train A

Preventing ‘Rear-end’ Collisions with help of ‘Networked ACD System’?



After detecting the presence of Loco ACD of Train A on same track (carrying same Track-ID), the Loco ACD of Train B would apply brakes to bring train to a STOP

Anti-Collision Device (ACD)



Hardware
486 Industrial PC,
Data Radio
GPS
Automatic braking Unit

Software/function
Operating system- DOS
Radio protocol- CSMA/CD
Latitude/ Longitude/speed/direction from true north
Normal braking and emergency braking

Why Telecommunicaton for Railways ?

Needed to ensure safe and efficient train operations

Failure in communication results in safety hazard & delays to trains

Types of Communication Requirements for Railways

- **Control Communication :** ***for train working***
- **Block Communication to ensure safety**
- **Level Crossing Gate Communication**
- **Emergency Communication : trains held up in section**
- **Communication for Disaster Management**
- **Administrative & Data Communication**
- **Mobile Communication : Trains & Control Centre**
- **Communication for Passenger Information Systems : IVRS, Train Indicators, Announcing Systems**

Railways Telecom Network

- **Optical Fibre** — **35782 Kms**
- **MW/UHF**
  - Digital — 5000 kms
  - Analog — 18500 kms
  - Total Towers — > 600
- **Underground RE cable** — **13279 kms**
- **Overhead alignment** — **25000 Kms**
- **PRS Network** — **> 600 nodes**

(Passenger Reservation System)

- **FOIS Netwok** — **> 300 nodes**

(Freight Operation & Information System)

- **Railnet**

Connects all Zonal HQs & most of Divisions

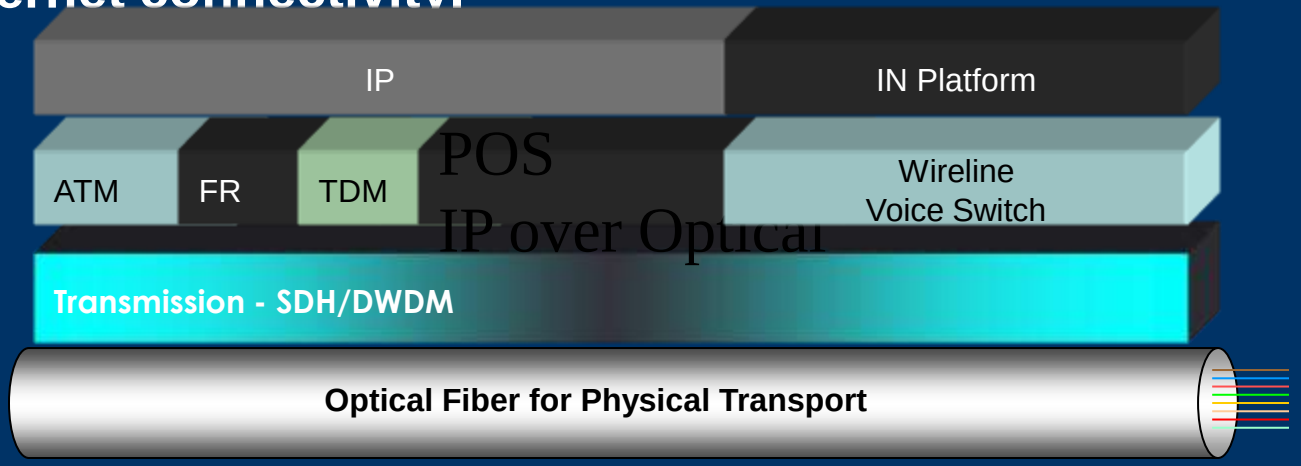
RailTel Corporation

formed in Sept 2000

- **To expeditiously modernise Railways Operational and Safety systems.**
- **Create a nationwide broadband telecom and multimedia network to supplement national infrastructure to spur growth of telecom, internet and IT enabled value added services in all parts of the country especially rural,remote and backward areas.**
- **Significantly contribute to realisation of goals and objectives of New Telecom Policy 1999.**
- **Generate much needed revenues for implementing Railways developmental projects, safety enhancement and assets replacement programs.**

Network Plans

- To create a state of the art OFC based network.
- The network to be based on SDH technology with Core layer of STM 16 for present with DWDM upgradeability, Edge layer of STM 4 and Access layer of STM 1.
- This to be overlaid by an IP layer of voice quality with Gigabit Ethernet connectivity.



- State of the art TDM / IP based switches for Long Distance carriage of traffic.

Present Status

- More than 35000 kms of OFC lit.
- OFC laying progressing at the speed of more than 500 kms per YEAR.
- The core network connecting 4 metro of Delhi, Mumbai, Kolkota, Chennai and 4 mini-metros of Ahmedabad, Pune, Secunderabad and Bangalore made ready .

Mobile Train Radio Communication

MOBILE TRAIN RADIO COMMUNICATION

** TO ESTABLISH INSTANT COMMUNICATION IN DUPLEX MODE BETWEEN:

- ## DRIVER & GUARD OF THE SAME TRAIN.
- ## DRIVER & GUARD AND A TRAIN CONTROLLER.
- ## TRAIN CREW & CONTROL CENTRE TO HANDLE EMERGENCIES, TECHNICAL & LOGISTIC PROBLEMS.
- ## MOBILE TRAINS.
- ## MOBILE & FIXED LOCATION SUBSCRIBERS.

WHY MTRC ? (Mobile Train Radio Communication)

- **CONVENTIONAL MODE OF COMMUNICATION WITH THE MOVING TRAIN IS AVAILABLE IN STATION AREA ONLY, THROUGH FIXED SIGNALS IN STATION LIMITS AND HAND / LAMP SIGNALS, WHICH COULD BE DISPLAYED BY STATION STAFF TO CONVEY GROUND SITUATION TO THE DRIVER/GUARD OF THE MOVING TRAIN.**

- **WALKIE-TALKIE SETS PROVIDED RECENTLY DO NOT CATER FOR AVAILABILITY OF ALL-TIME & CONTINUOUS COMMUNICATION BETWEEN DRIVER/GUARD AND STATION/CONTROLLER.**

- **UEC SYSTEMS HAVE ALSO NOT PROVED FULLY EFFECTIVE & USEFUL ON HEAVY DENSITY ROUTES.**

  * **SIMPLEX MODE OF WORKING – REQUIRES DISCIPLINE IN USE.**
  * **NOISY FREQUENCY BAND.**
  * **ALL USERS ON ONE FREQUENCY – CREATES CONFUSION & MAY NOT BE AVAILABLE WHEN NEEDED MOST.**

- **WITH INCREASE IN SPEED & NUMBER OF TRAINS, RELIABLE & INSTANT COMMUNICATION WITH FAST CALL SET-UP TIME BETWEEN DRIVER & GUARD AND DRIVER/GUARD AND CONTROLLER IS ESSENTIAL.**

MTRC

- **ENHANCES SAFETY:**

  * CAN ELIMINATE FATAL ACCIDENTS IN CERTAIN SITUATIONS.

- **PROVIDES INSTANT COMMUNICATION:**

  * TO CONTROL FROM SITE OF ACCIDENTS.
  * TO DRIVER IN THE VICINITY OF AFFECTED TRAIN TO AVERT ACCIDENTS.

- **IMPROVES OPERATIONAL EFFECTIVENESS & EFFICIENCY:**

  * IMPROVES TRAIN RUNNING TRHOUGH BETTER MONITORING.
  * CUTS DOWN ON DURATION OF BLOCKS – ENGINEERING & POWER.
  * HELPS IN TROUBLE SHOOTING AND SENDS TIMELY INFORMATION TO CONTROL ON LOCO FAILURES, C & W DEFECTS, AND LAW & ORDER PROBLEMS.

Contd…

MTRC

- **AIDS IN RELIEF OPERATIONS DURING ACCIDENT SITUATIONS:**

  *** CONSTANT FLOW OF TWO – WAY INFORMATION FOR DIRECTIVES FROM CONTROL AND ASSISTANCE NEEDED AT ACCIDENT SITE.**

- **IMPROVES CORPORATE IMAGE:**

  *** PROVIDES POSITIVE SIGNALS TO PUBLIC AT LARGE FOR MEASURES TAKEN ON IR IN SAFETY MATTERS.**

- **PROVIDES POTENTIAL FOR COMMERCIAL EXPLOITATION:**

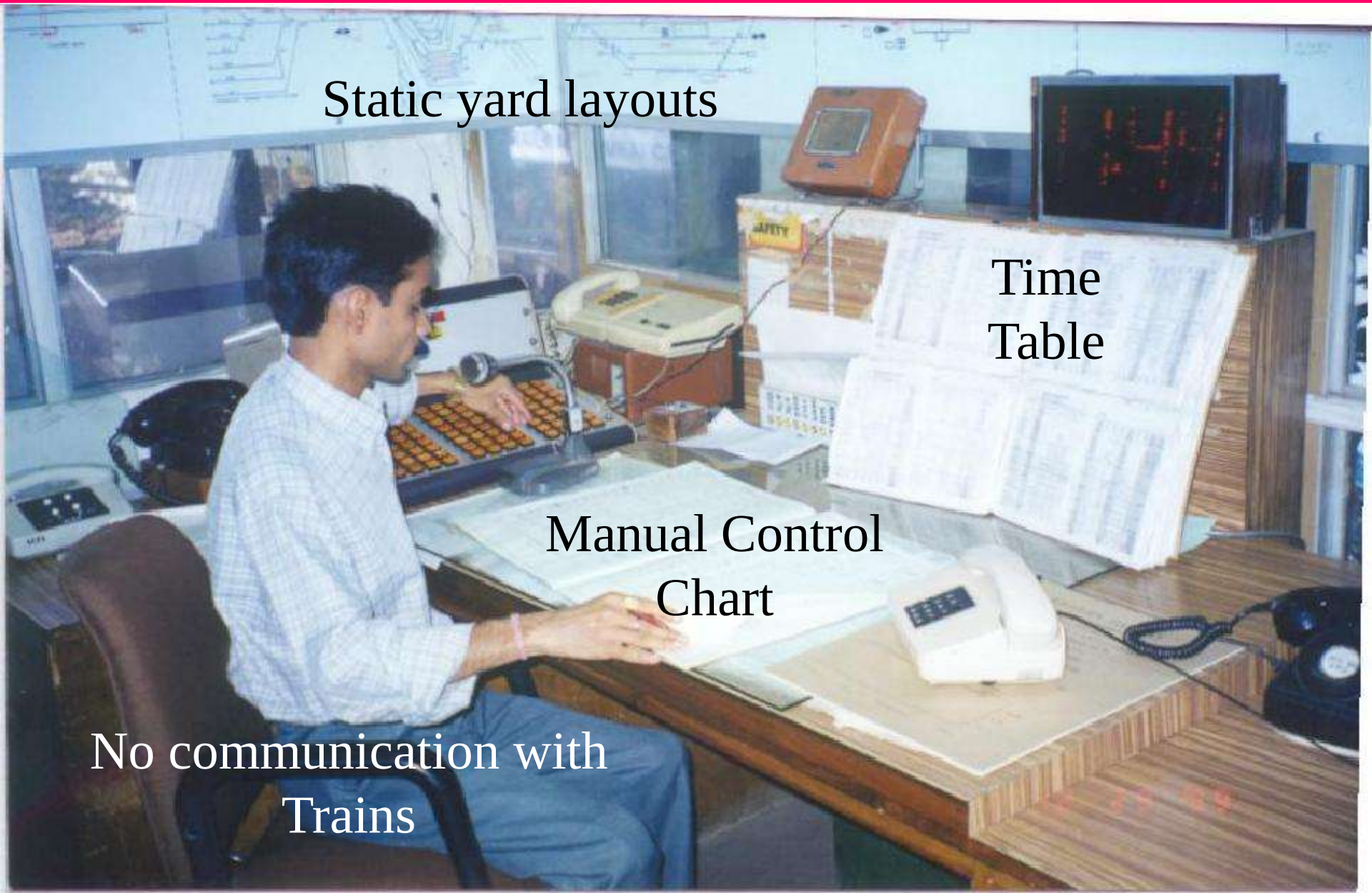
  *** MOBILE PHONES TO TRAVELLING PASSENGERS.**
  *** RURAL COMMUNICATION IN A REASONABLY WIDE CORRIDOR ALONG THE TRACK.**

Induction of Modern Signalling & Telecom in Rail Transport paving way for higher levels of Safety, Management of Rail Operations and Passenger Comforts

TRAIN MANAGEMENT SYSTEM

On Churchgate Virar Mumbai Suburban Section

Before TMS, Our Traffic Controllers were managing train operations in the old fashioned way…



Induction of Modern Signalling & Telecom in Rail Transport paving way for higher levels of Safety, Management of Rail Operations and Passenger Comforts

TRAIN MANAGEMENT SYSTEM

On Churchgate Virar Mumbai Suburban Section

TMS Project on Western Railway

Real Time Train Arrival Status for Commuters with automatic announcements

Real Time Train Movements and Live Signalling Indications for Rail Operations

Mobile Communication

…..competing with Nature's beauty……