कवच Kavach

(Architecture)

(Kavach D&D Course : 05.12.2023, 09.00 AM)

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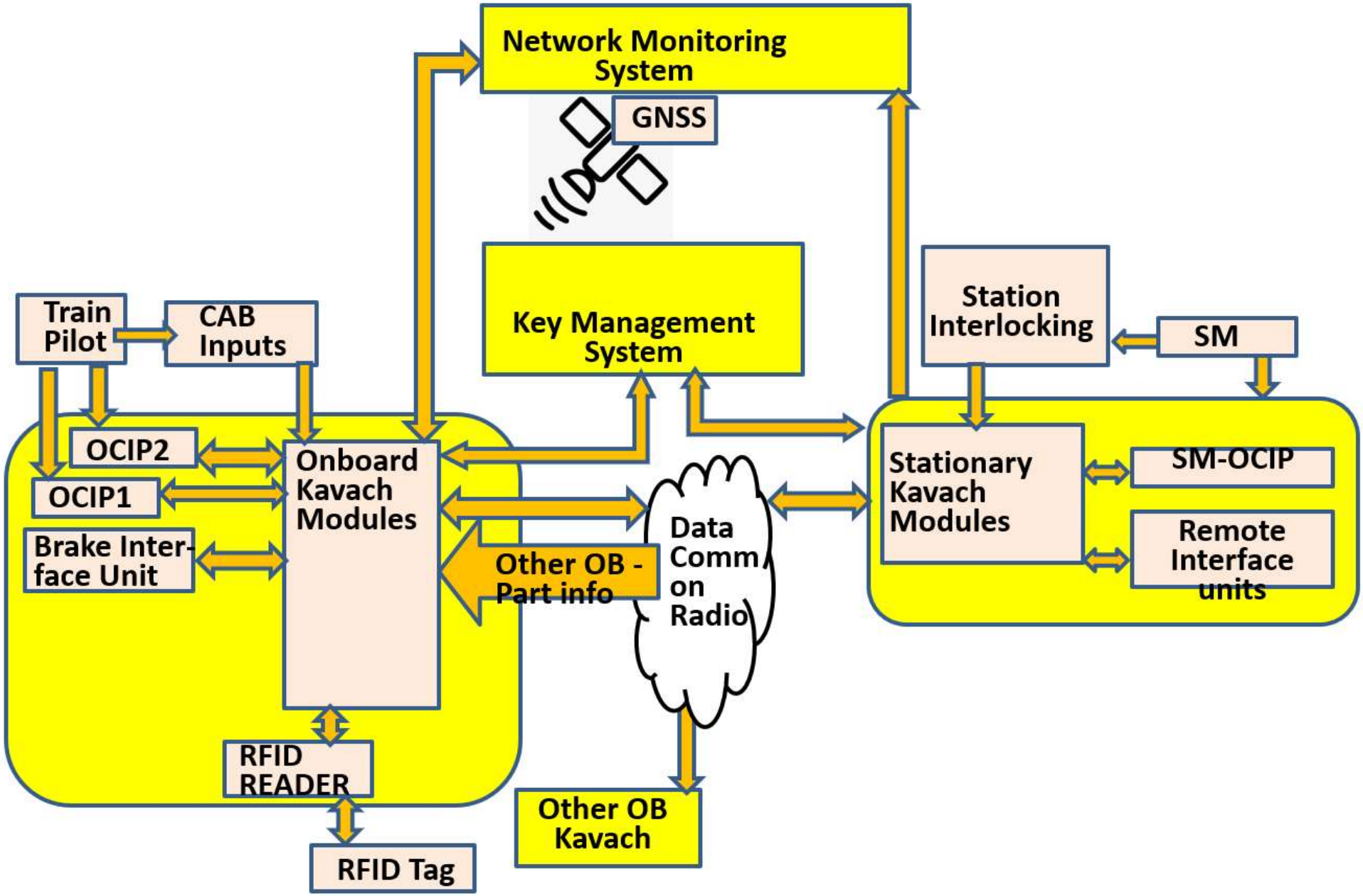
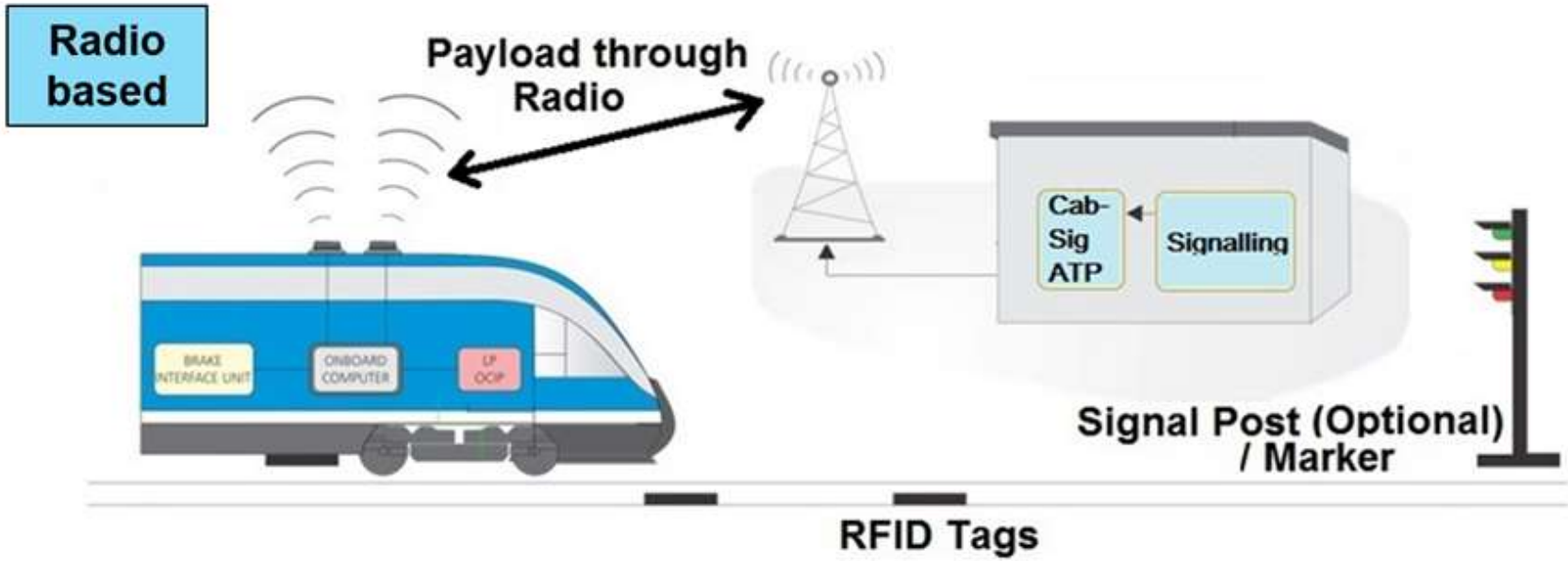
Evolution of Signalling System : Ultimate User : Train Driver

Current Kavach Architecture



Major Functional Components of Kavach



- ATP pre-requisite of running trains at 140kmph (Signal Engg Manual).
- 'Radio-based' ATP systems are capable of enhancing line capacity, 'Spot transmission' type ATP systems are detrimental to Line Capacity.
- Indigenous Kavach System is 'radio-based' ATP system.
- Very few countries have their own indigenously developed such system
- Kavach design without compromising stringent world class norms.
- 03 Indian Sources already approved after rigorous assessment, trials.
- To be rolled out in big way with Delhi-Howrah, Delhi-Mumbai on Priority.

Kavach – Station Equipment

2 x 2 = 4
Antennae

Tower

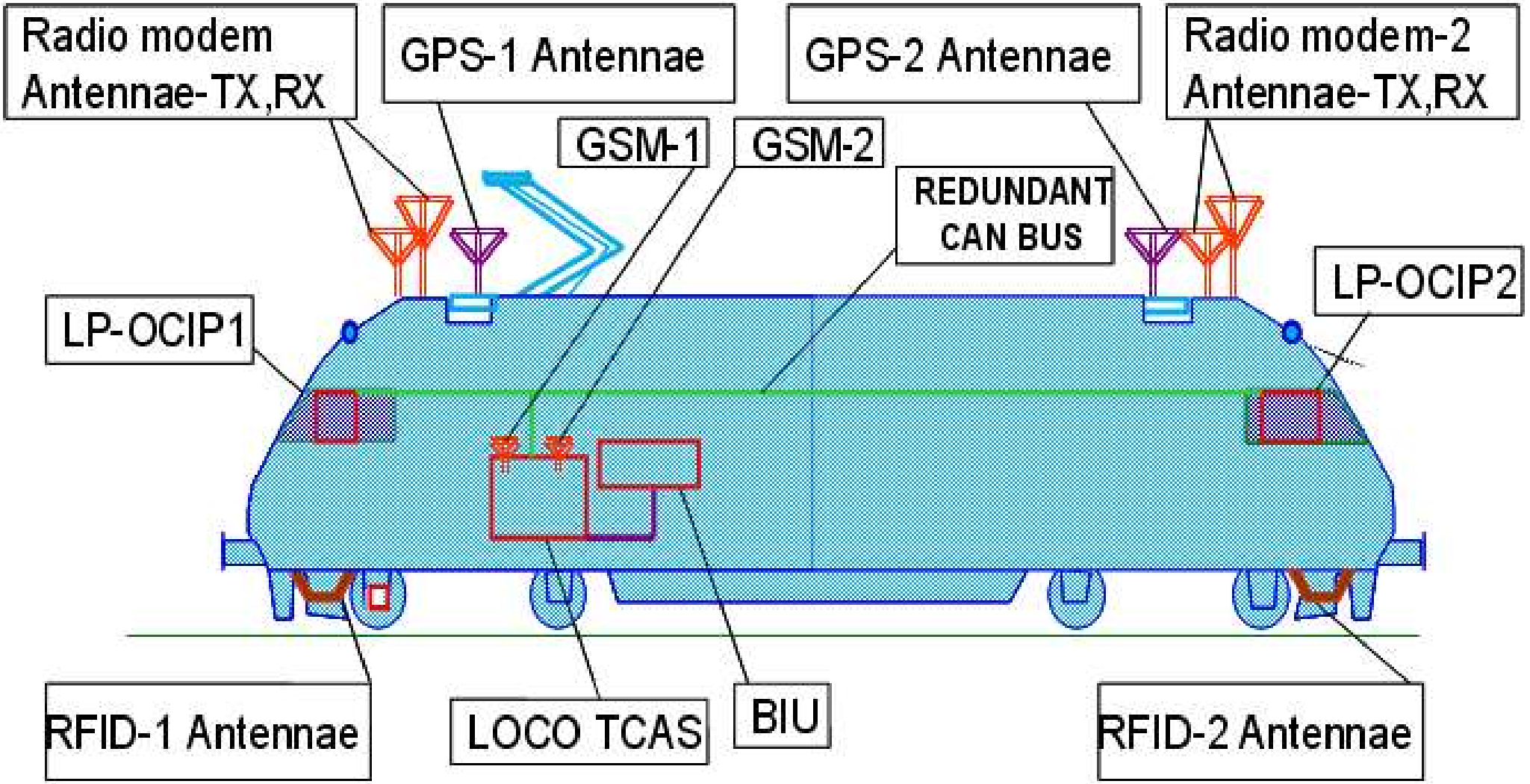
Radio
Unit

Kavach Vital computer

Interlocking
(Relay Room)

SM-OCIP

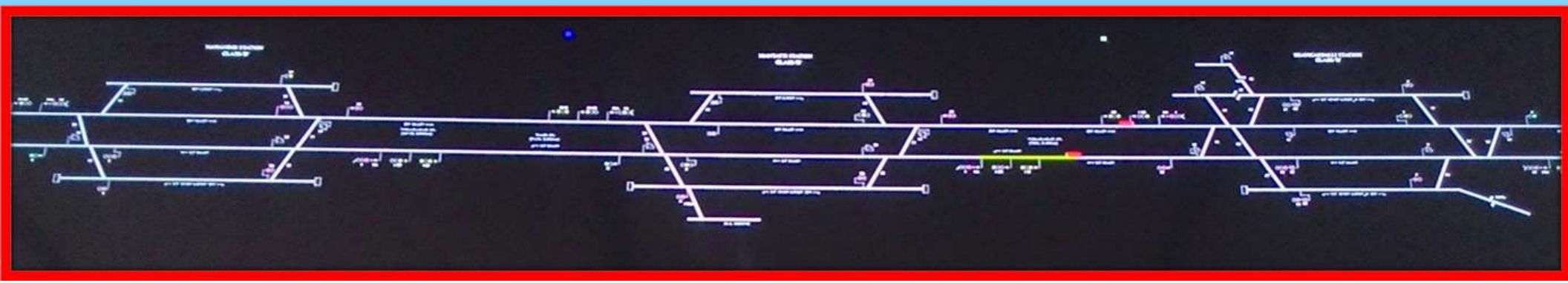
TCAS – Loco Equipment



RFID Technology: Determination of Train Location

- RFID Tags provides track and location reference information apart from other static information.
- In conjunction with odometry, it provides safe current location of train .

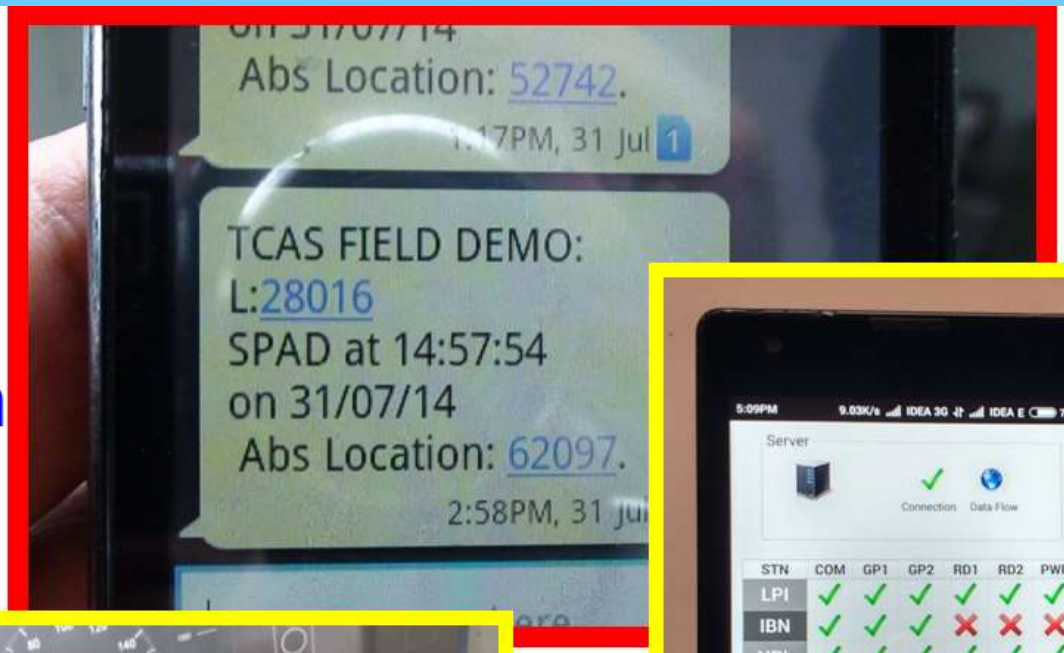
Kavach : Networked Monitor System

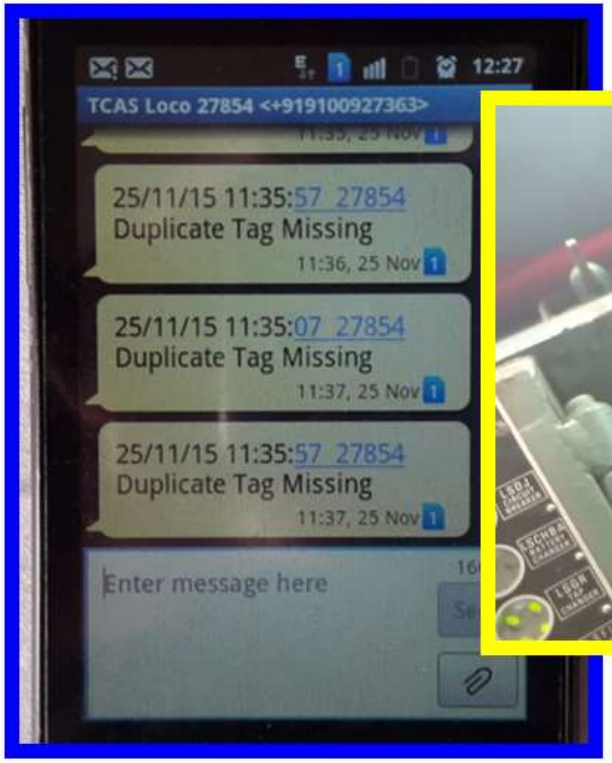


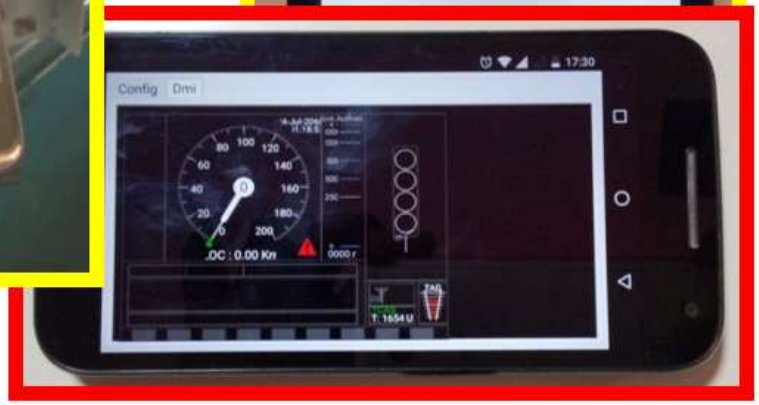
- Real-time Display of train movement on NMS monitors.
- Offline Simulation of Train Movements.
- Ability to extract offline log through NMS
- Generation of Exception Reports
- Display of "Speed V/s Location" and "Speed V/s Time".

Kavach : Health Monitoring

- Prompts and SMS Alerts
- Statistical Reports
- Web-based Application
- Convenient monitoring on Portable device







What is Automatic Train Protection, Types

Automatic Application of brakes in case of speed in excess of permitted speed at that spot.

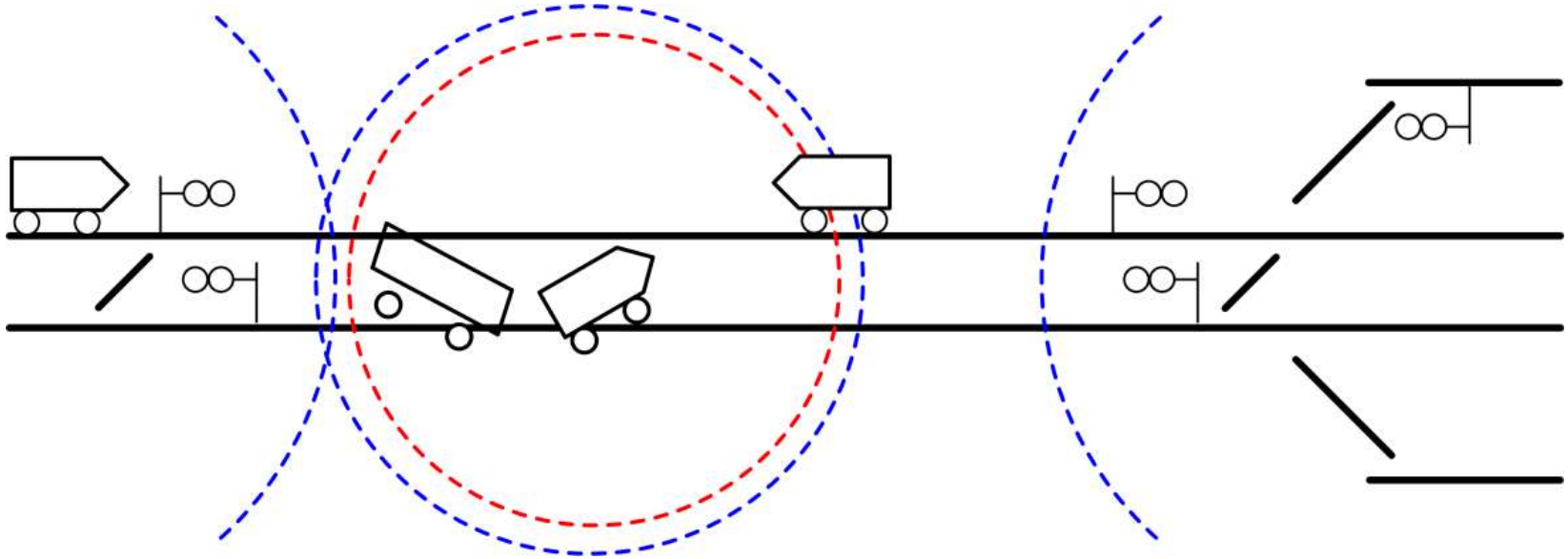
Protection against inadequate braking by Pilot of Self Train:

- **Protection against Collisions due to (SPAD)**
- **Protection against Over-speeding (Speed Restrictions, Turnouts)**
- **Protection against Rollback of Train**

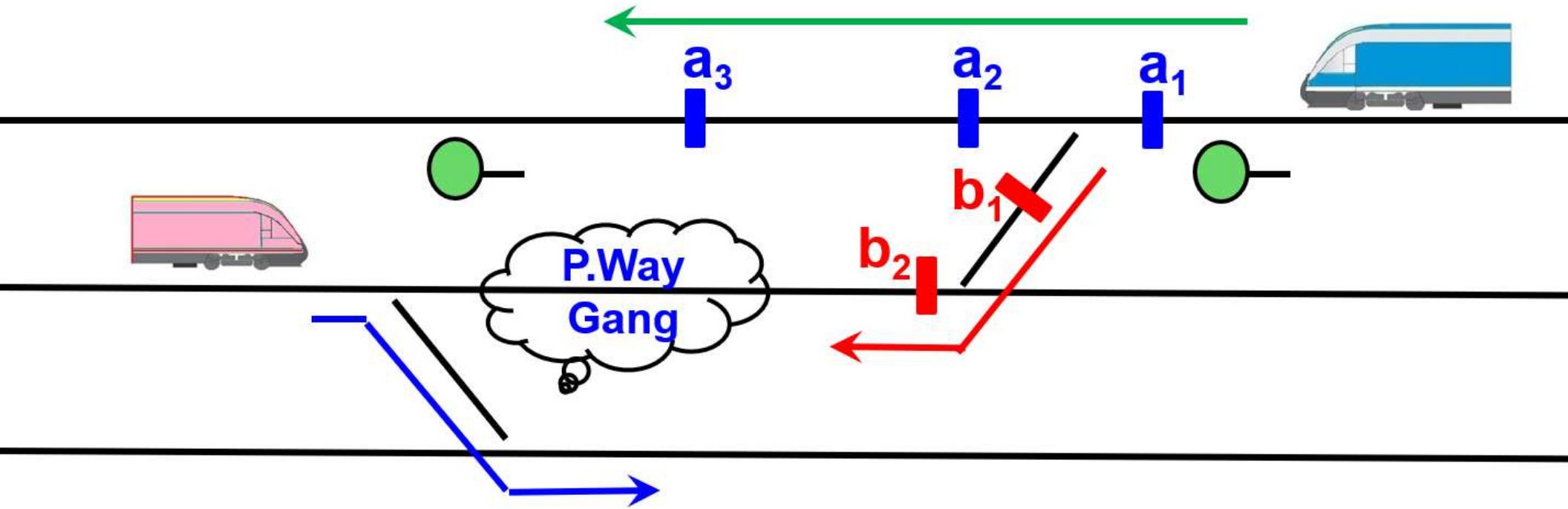
Protection against unusual caused due factors external to Self Train:

- **Protection against Head-on Collision (Non-signalled Movement)**
- **Protection against Rear-end Collision (Non-Signalled Movement)**
- **Protection against hitting another derailed train under infringement**
- **Protection against routing of train inconsistent with signal aspect**
- **Protection against any observed Emergency Situation**

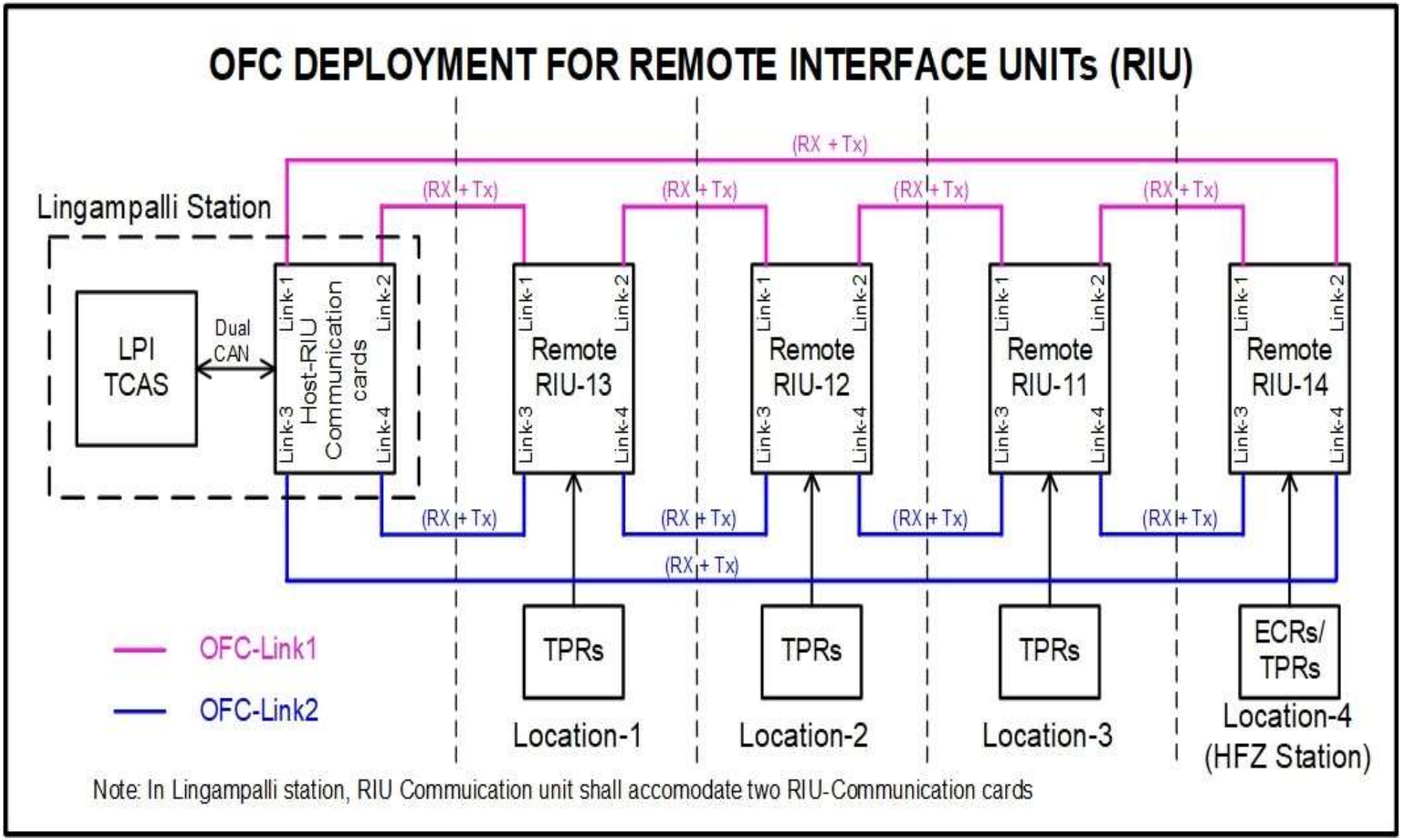
Unusual Stoppage detection by other surrounding Trains



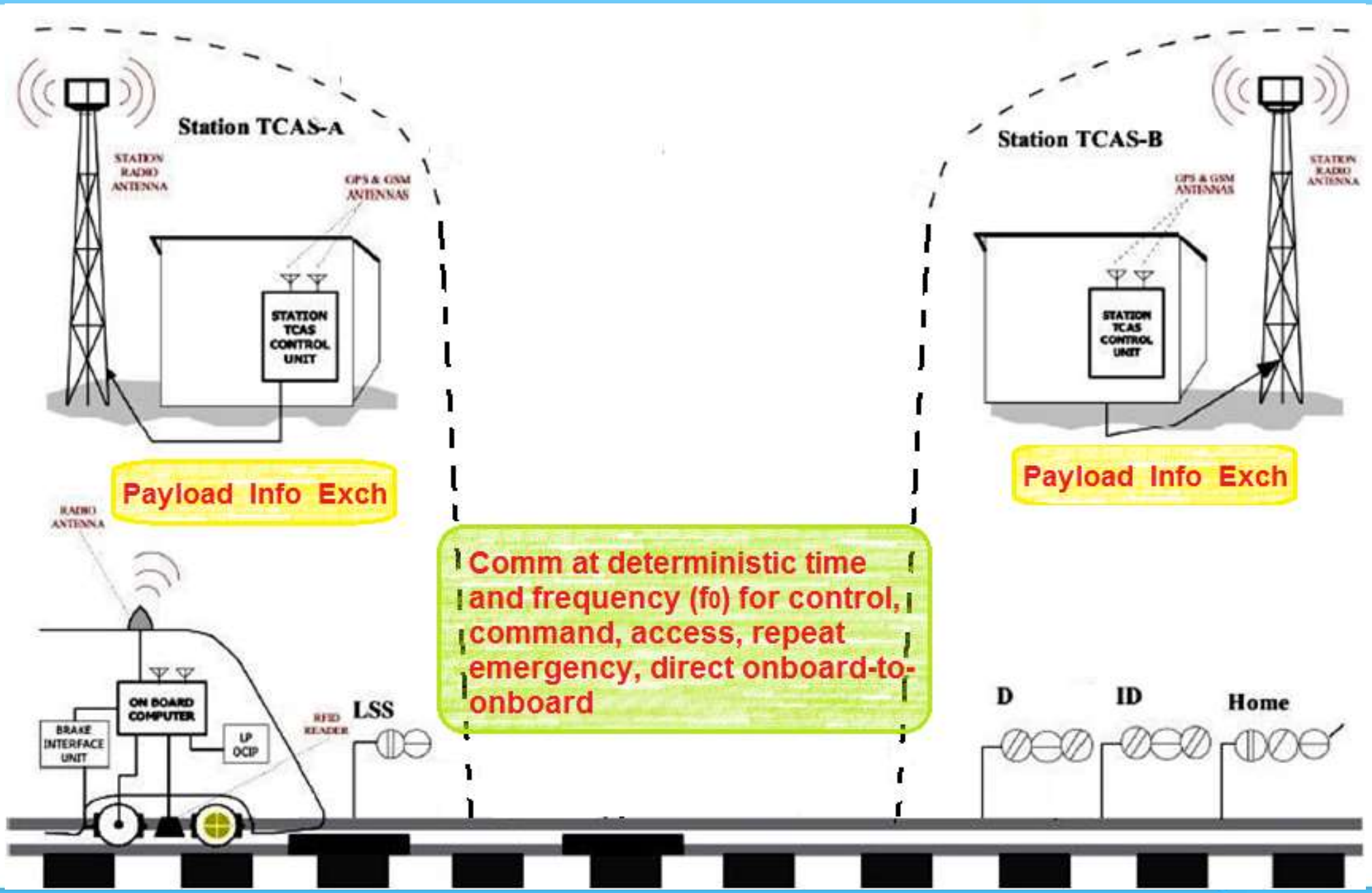
Protection against routing of train inconsistent with signal aspects



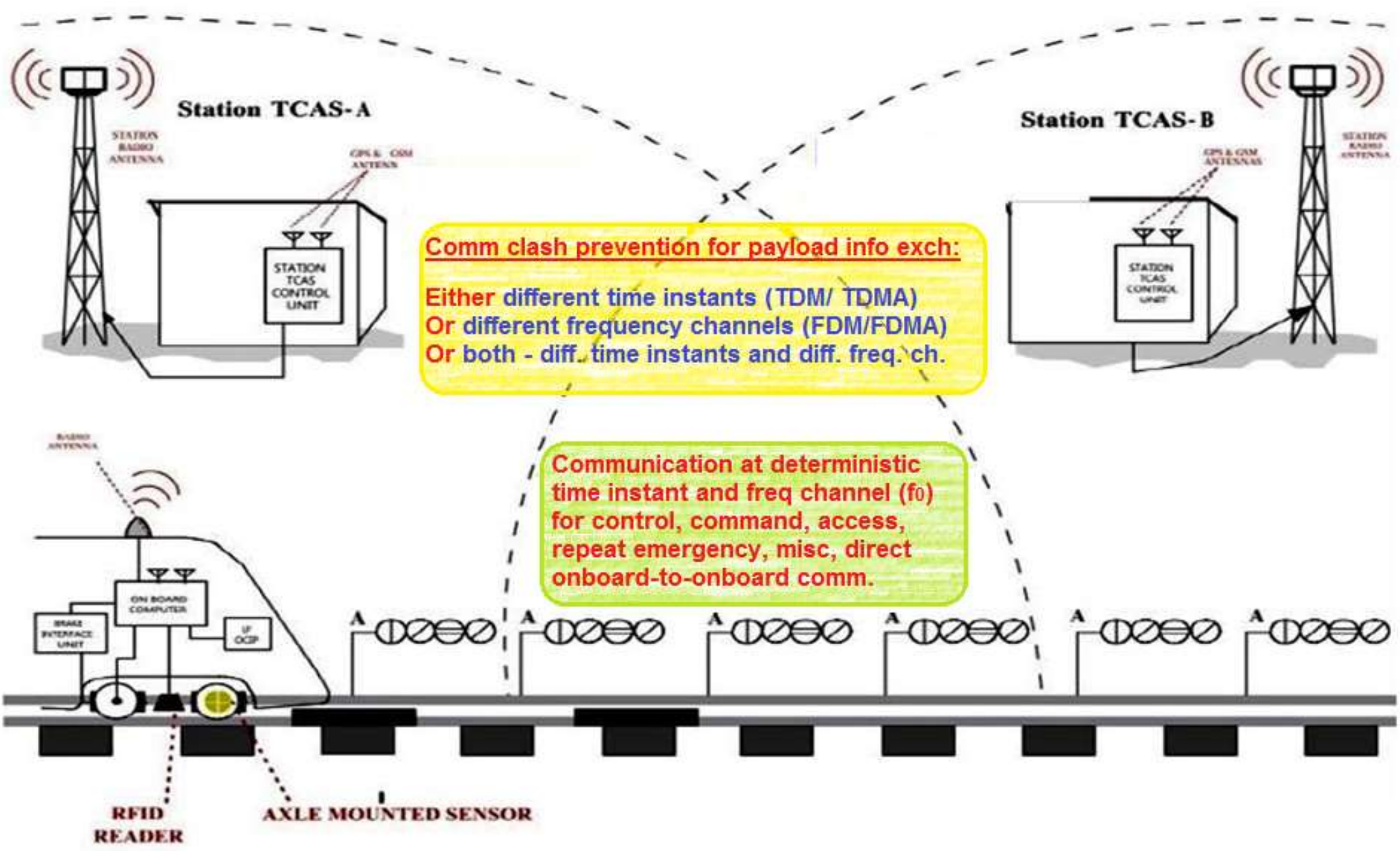
Dual Ring Connectivity in Auto Section



Absolute Block Section : Communication Mandatory Zone



Auto Signalling Sections : Overlapping Jurisdictions



Kavach (TCAS) – A Glimpse of components

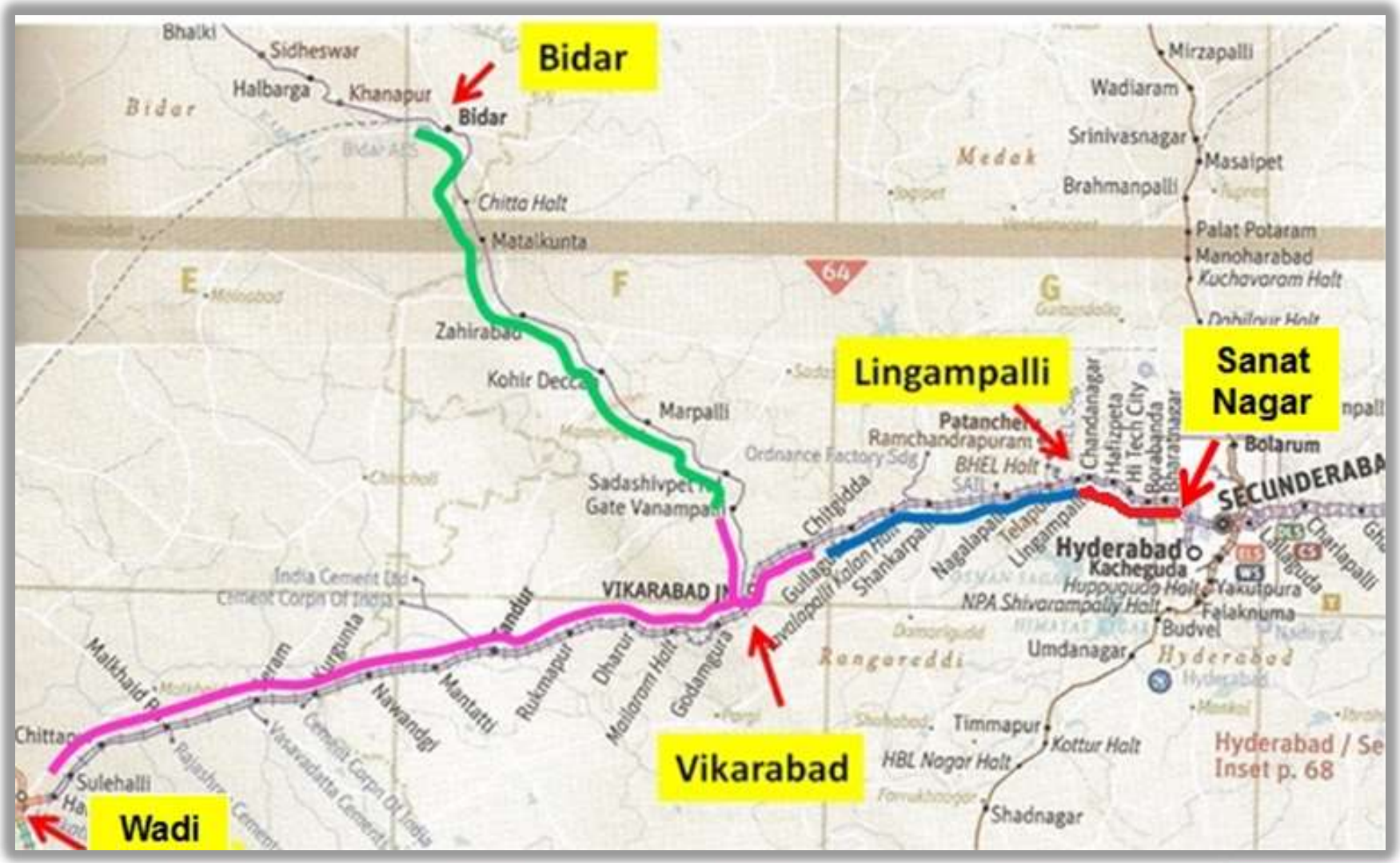
Multi-source Interoperability based on open protocols to avoid monopoly

Demo of Line Capacity Enhancement in Auto Signalling Section

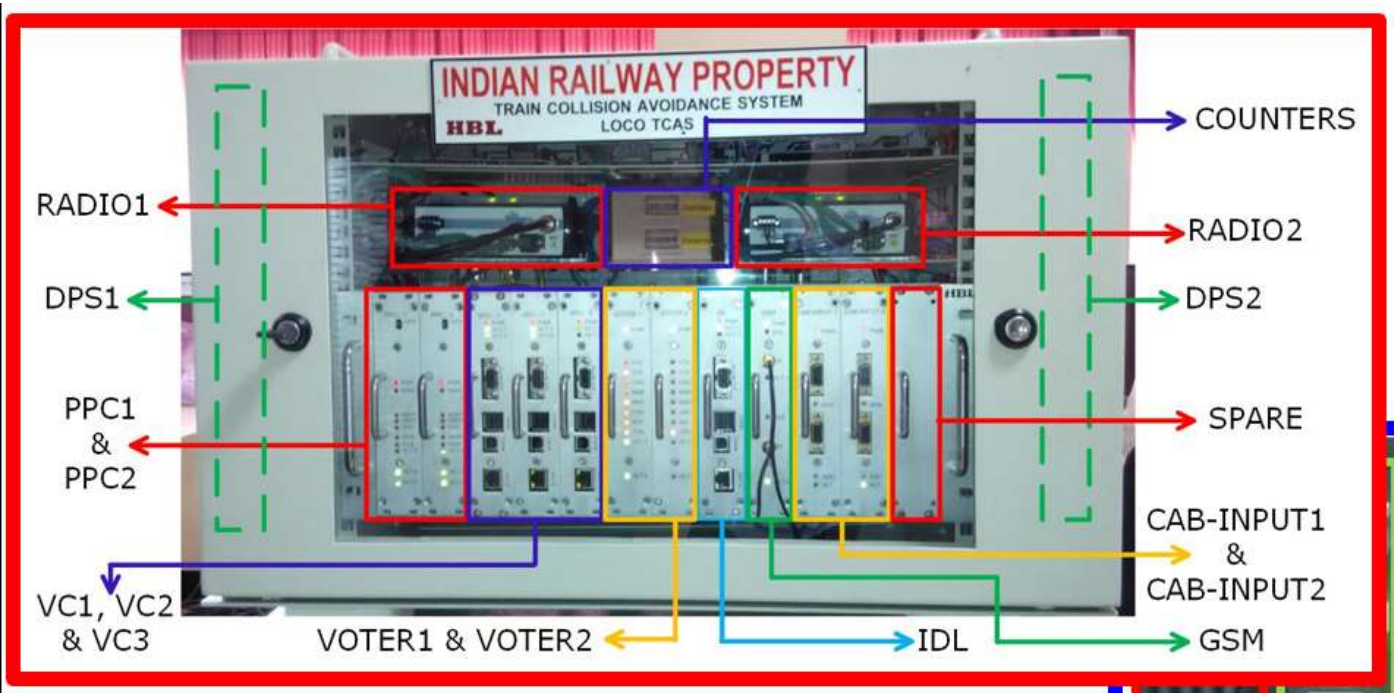
- **In 2015, the Auto Signalling Section Sanatnagar – Hafizpeta - Lingampalli was added to original 250km section to demonstrate advantages of radio-based system for Line Capacity Enhancement.**

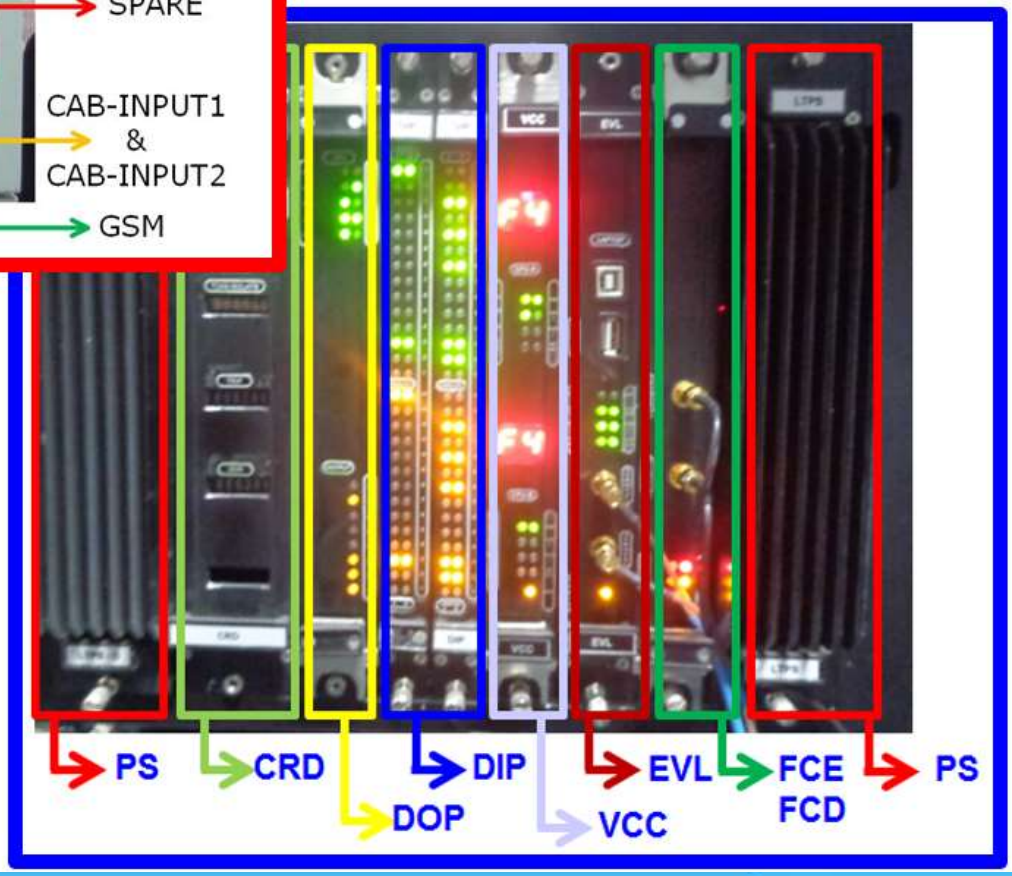
Colour Legend:

- Medha
- Kernex
- HBL
- All 03 in Auto Sig Section



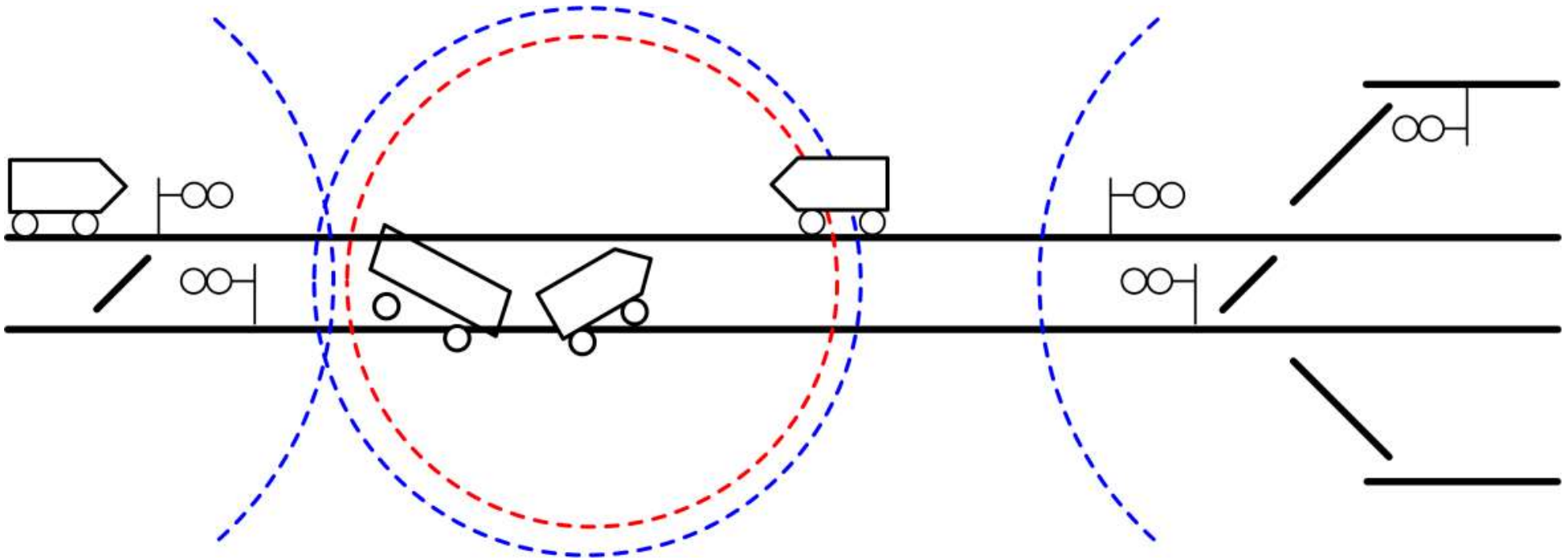
Multi-vendor Interoperability



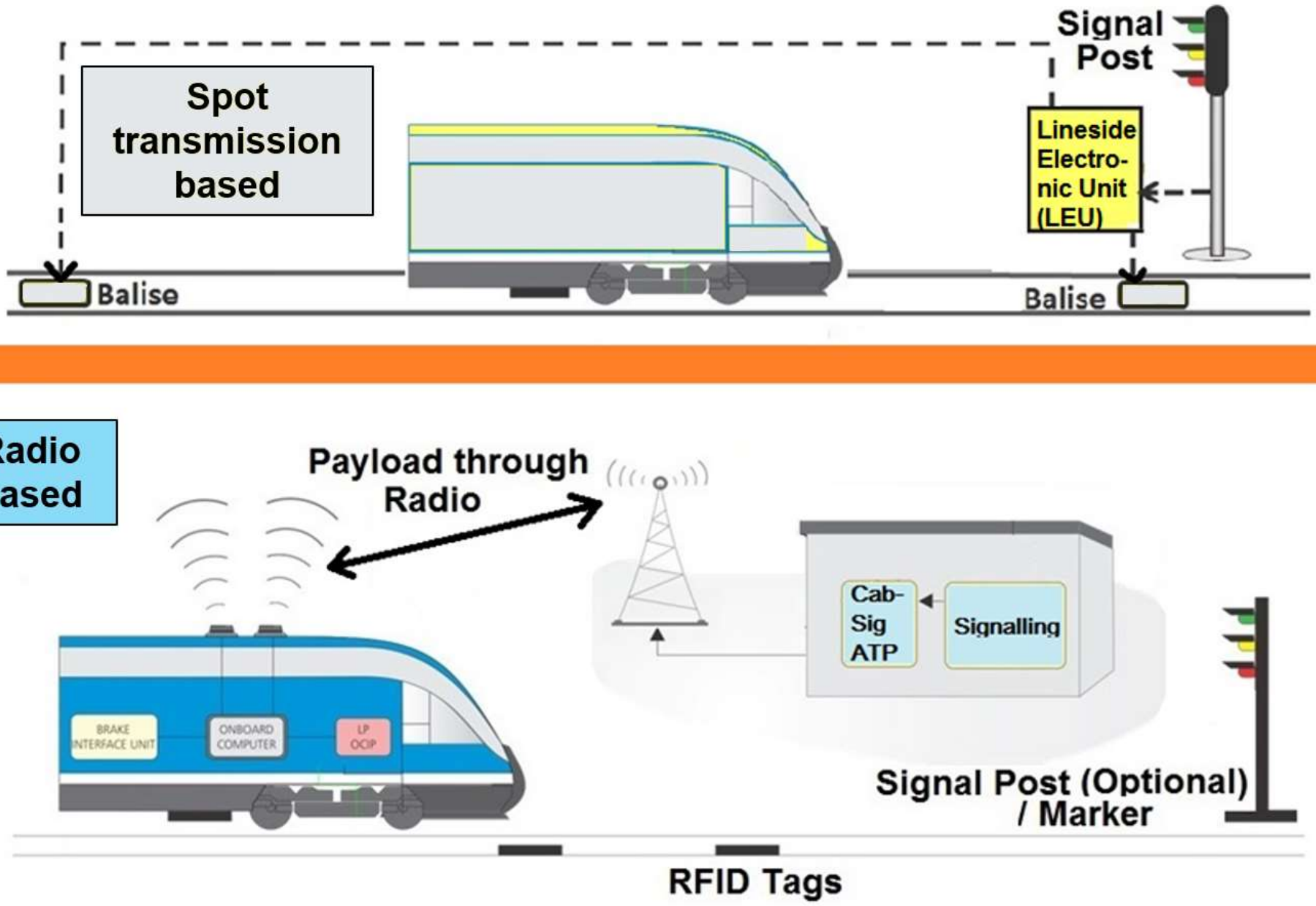


- Different Hardware, Different Firmware
- Common protocols, Common logics

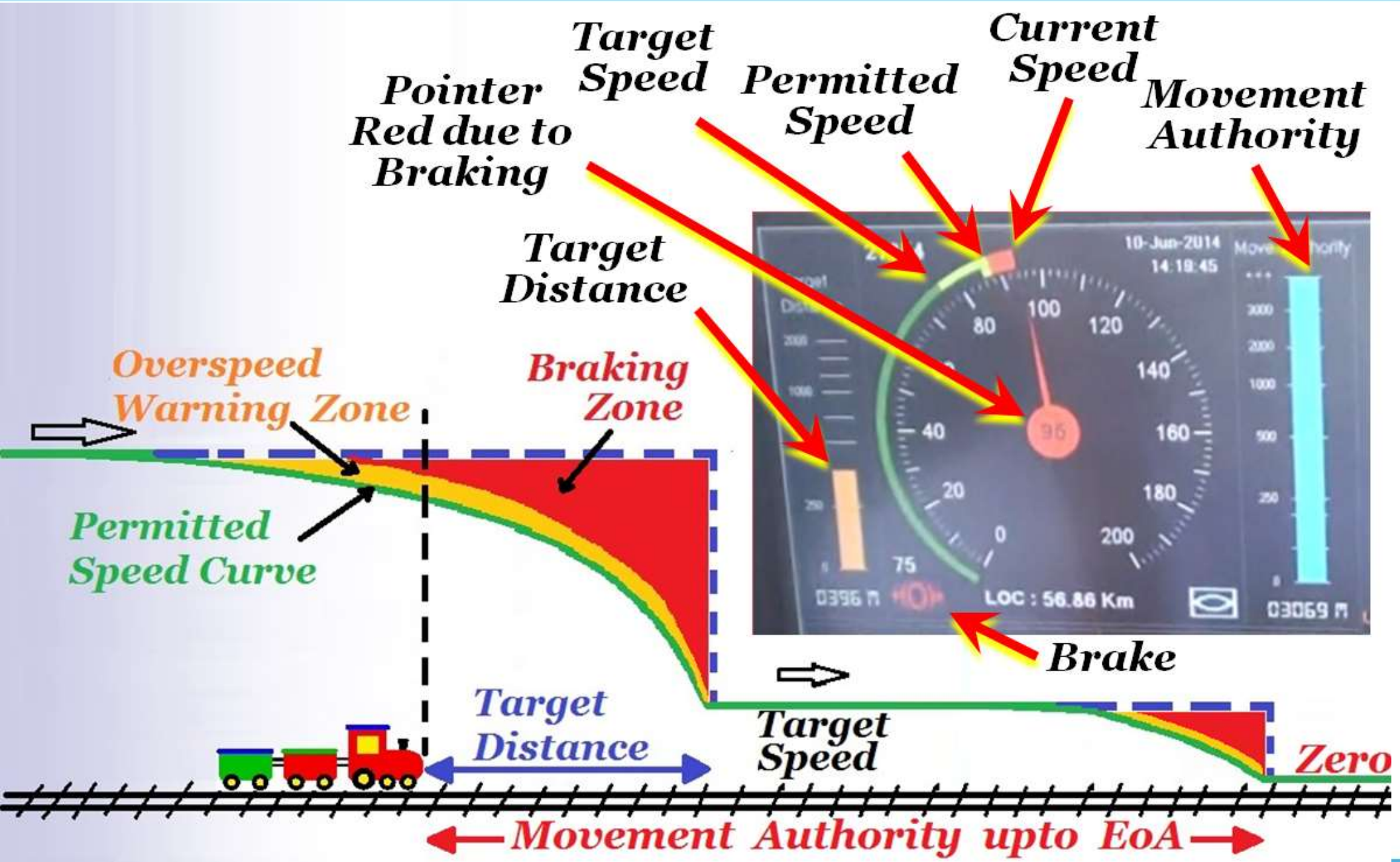
Unusual Stoppage detection by other surrounding Onboard



Architecture of Spot ATP and Kavach (Radio based ATP)



Elements of Conventional Cab-signalling



Conventional Cab-Signalling Vs Lineside Signal Aspects

More Informative:

Guides LP in advance to optimally follow speed curve taking into account:

- Dynamic Situation : Route authority
- Static Information : Gradient, SRs, Distances
- Braking Characteristics of Train
- Not affected by very short duration transient failures

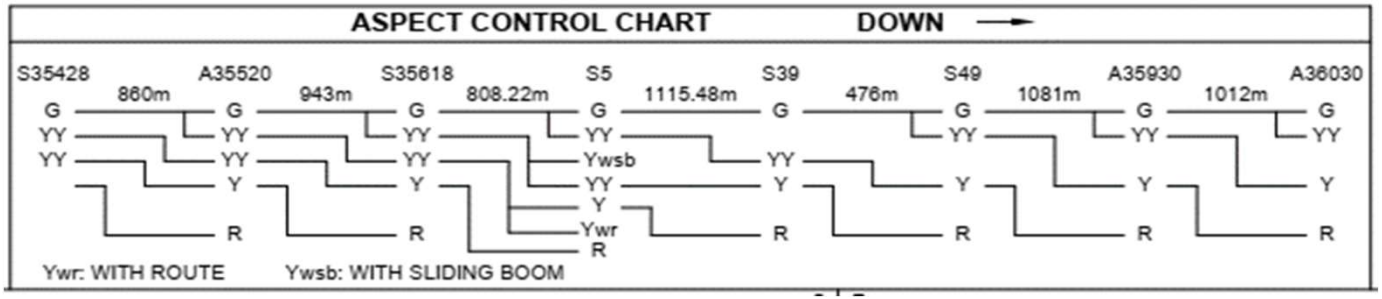
Limited Information:

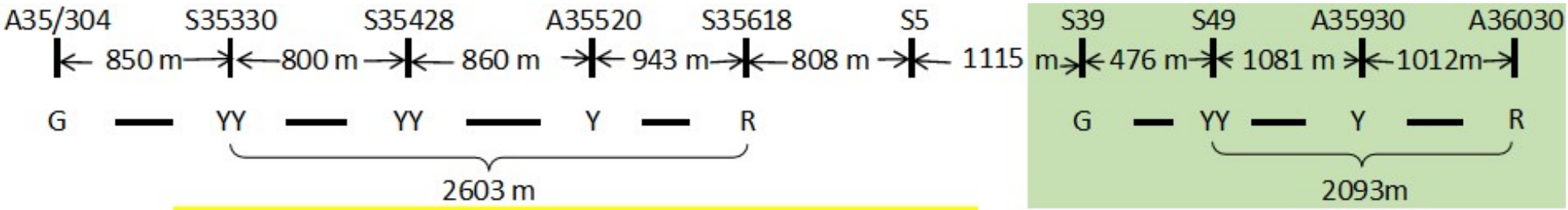
- Rely on Road Learning skills
- Lineside Signal aspects exhibited for train with worst braking characteristics affecting Line Capacity
- Irritation during very short duration comm. failure etc.

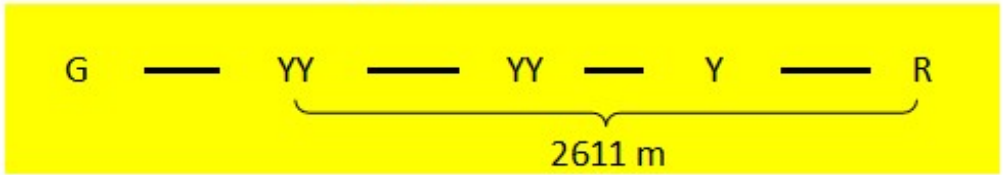
- Since inception of design, Signal aspect doesn't play any role in permitted speed curve assessment or braking, it is just for exhibit and its display can be turned off very easily either from Stationary or Onboard setting.
- It is high time for LPs to start using Speed Dial, MA Bar, Target Distance Bar etc instead of Signal Aspects so as to have advantage of distance-to-go Cab-signalling for enhanced safety and operations.

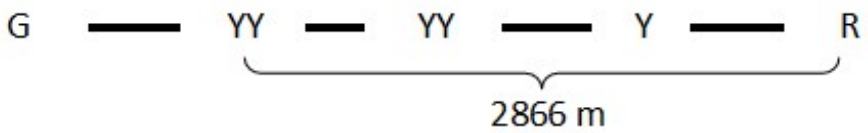
Kavach (TCAS) – Driver Machine Interface

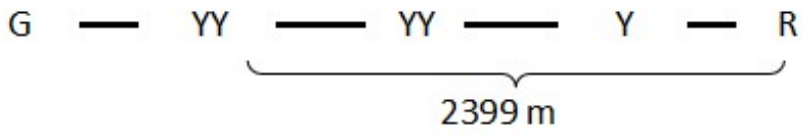
Unduly Restrictive Signal Aspect Sequence : Limitation of Lineside Signals to cater trains with worst braking characteristics



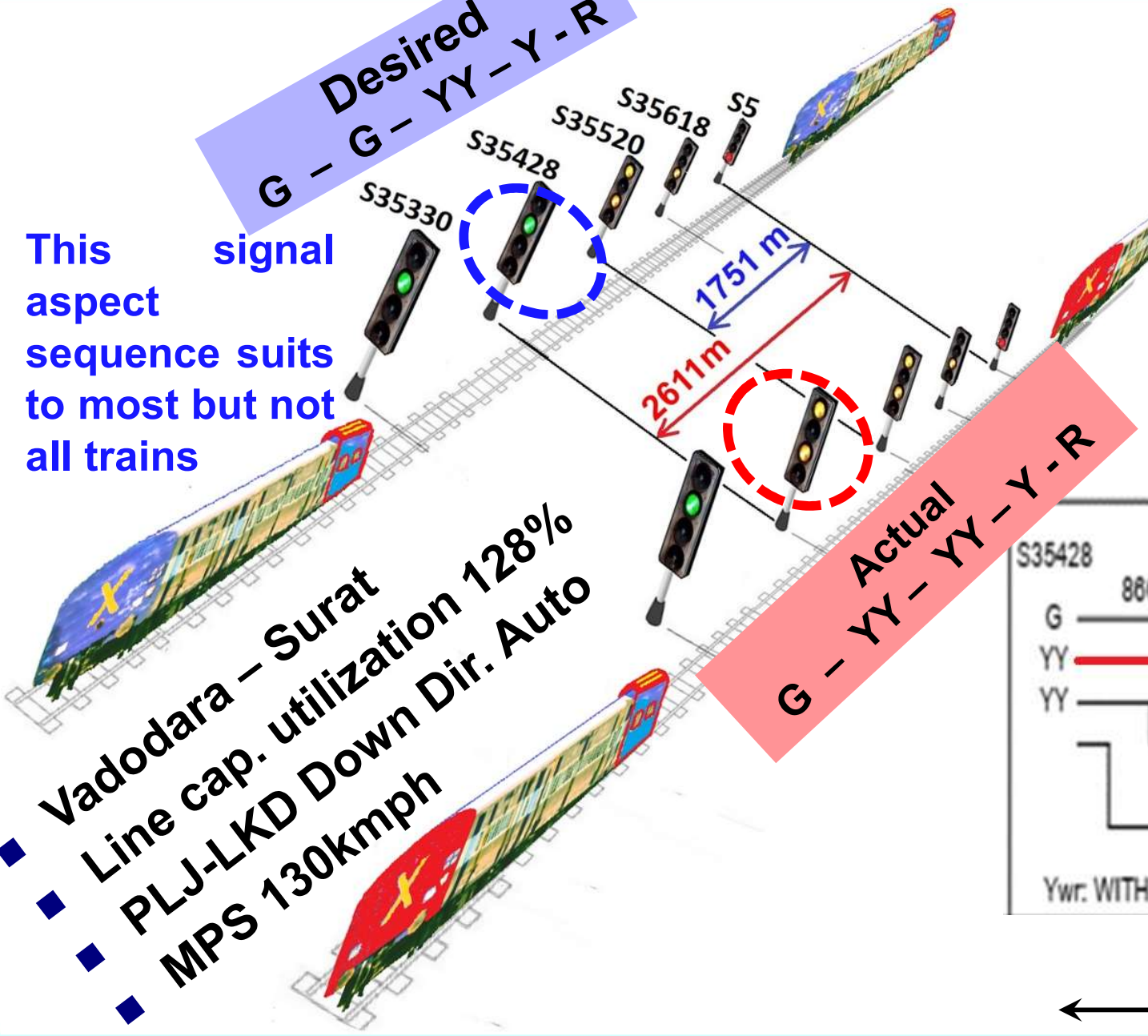








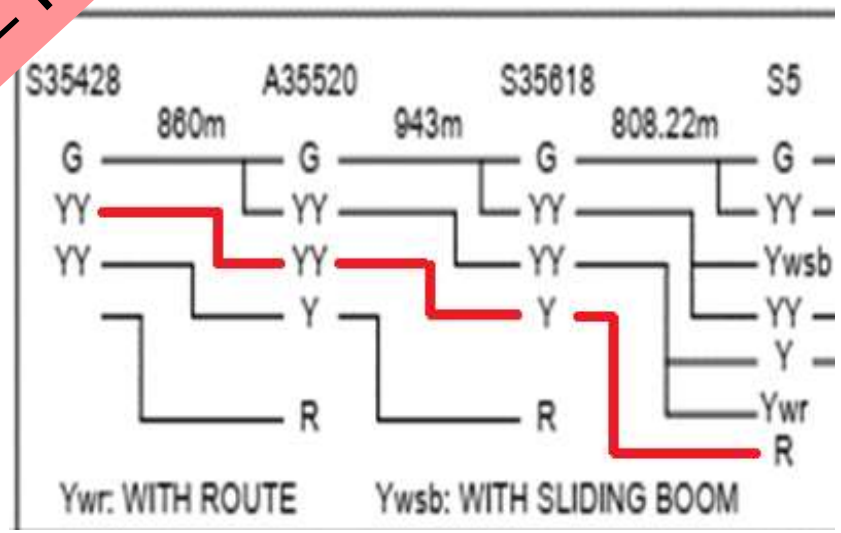
Unduly Restrictive Signal Aspect Sequence : Limitation of Lineside Signals to cater trains with worst braking characteristics



This signal aspect sequence suits to most but not all trains

- Vadodara – Surat
- Line cap. utilization 128%
- PLJ-LKD Down Dir. Auto
- MPS 130kmph

However, lineside signal aspect sequences are arranged to take care of train with worst braking characteristics and hence unduly exhibit restrictive aspect sequence.



1751 m

2611 m

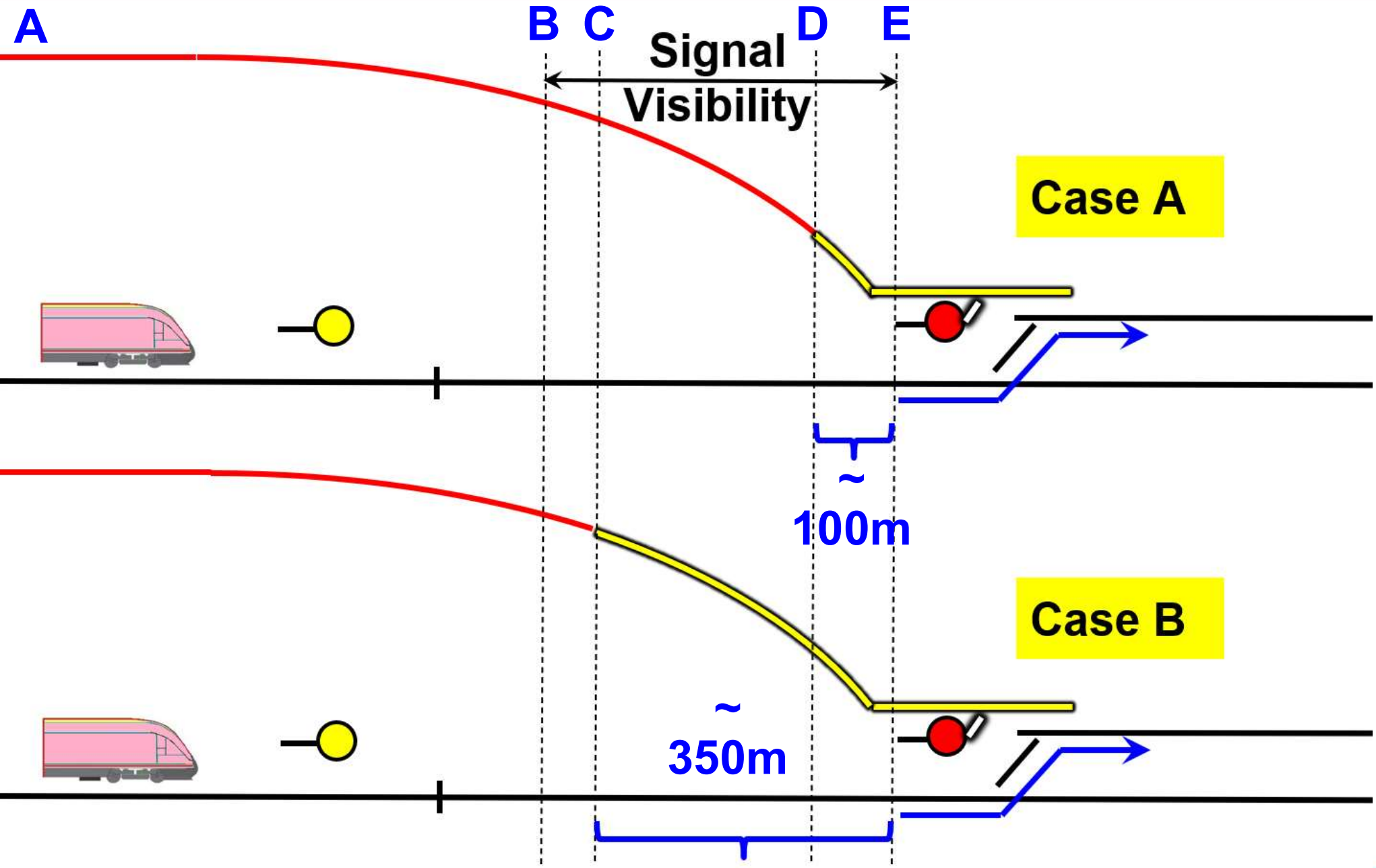
Migration from Signal Aspect to Conventional Cab Signalling to realize the benefit of Line Capacity Enhancement

Pilots/Motormen on IR have been habitual of using this.

We started showing them both Signal Aspects and Conventional Cab-signalling as part of cab-signalling

We should stop showing Signal Aspects so that Pilots/ Motormen start using Conventional Cab-signalling to achieve Line Capacity Enhancement.

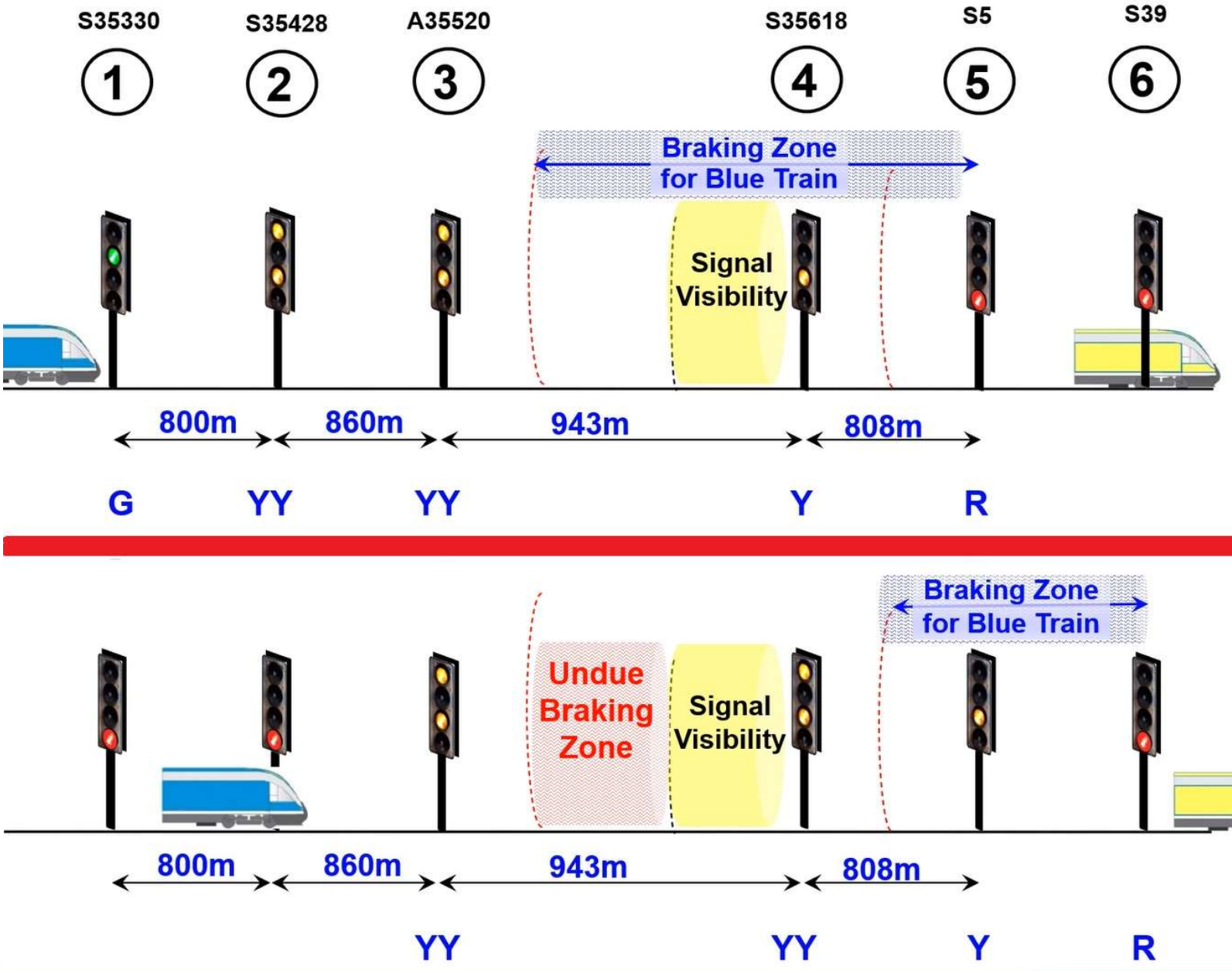
Main Approach from Red (MAR) Control : UK Rly Signalling



Lineside Signal Aspect Sequence : Safety, Operation issues

Effect on Movement of trains when trains follow one after another.

Scenario: Signal 5 clears once blue train crosses Signal 2.



Options of Info Transfer Mechanisms for ATP Development

- **Development of MComm as substitute of GSM-R, LTE to act as Communication Backbone of ATP system, triggered the development of radio-based Cab-signalling IR-ATP Kavach.**

Spot Transmission:

- Adverse to Line Capacity
- Simple Design
- One-way Info flow at certain spots
- Cables, Trackside Electronics
- Hindrance to Track/ P.Way

Radio-based Transfer:

- Line Capacity Friendliness
- Line Capacity Enhancement
- Multi-way Info flow
- Needs Radio Communication
- GSM-R obsolescence
- LTE wasn't available, wait

Conclusion

- An ATP as overlay on an underlying signalling system needs exchange of lot of data on realtime basis.
- Radio based ATP systems are line capacity friendly whereas spot transmission type systems are detrimental to line capacity.
- Radio based ATP systems don't require infill and thus don't need cabling for the same.
- Radio based systems are less susceptible to P.Way work.
- Onboard to Onboard (Vehicle-to-Vehicle) communication is possible in radio based systems.

Kavach

Thanks for Watching

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