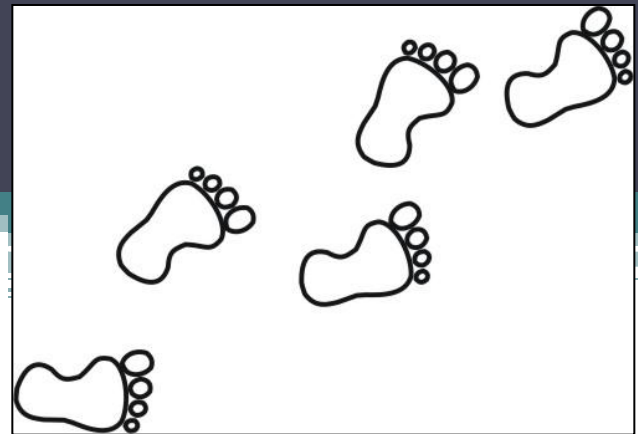# TPWS in action

Decisive steps towards main line ATP on IR

Akhilesh Yadav,
Director/ Signal/ RDSO

Outline of presentation

1. IR requirements for ATP

2. Roadmap

3. Current installations

4. Lessons learnt from various projects

5. Application Design & Engineering Issues

6. TPWS related activities @ RDSO

Indian Railway Requirements for Mainline ATP

- Provide SPAD protection
- Provide in-CAB signalling for all weather operations
- Aid to driver to control train in safe manner
- Configurable and consistent with existing signalling rules
- Mature technology upgradable to full cab signalling
- Multivendor support and future proof

Chosen system: TPWS

Train Protection & Warning System (TPWS)

- Based on ETCS core architecture
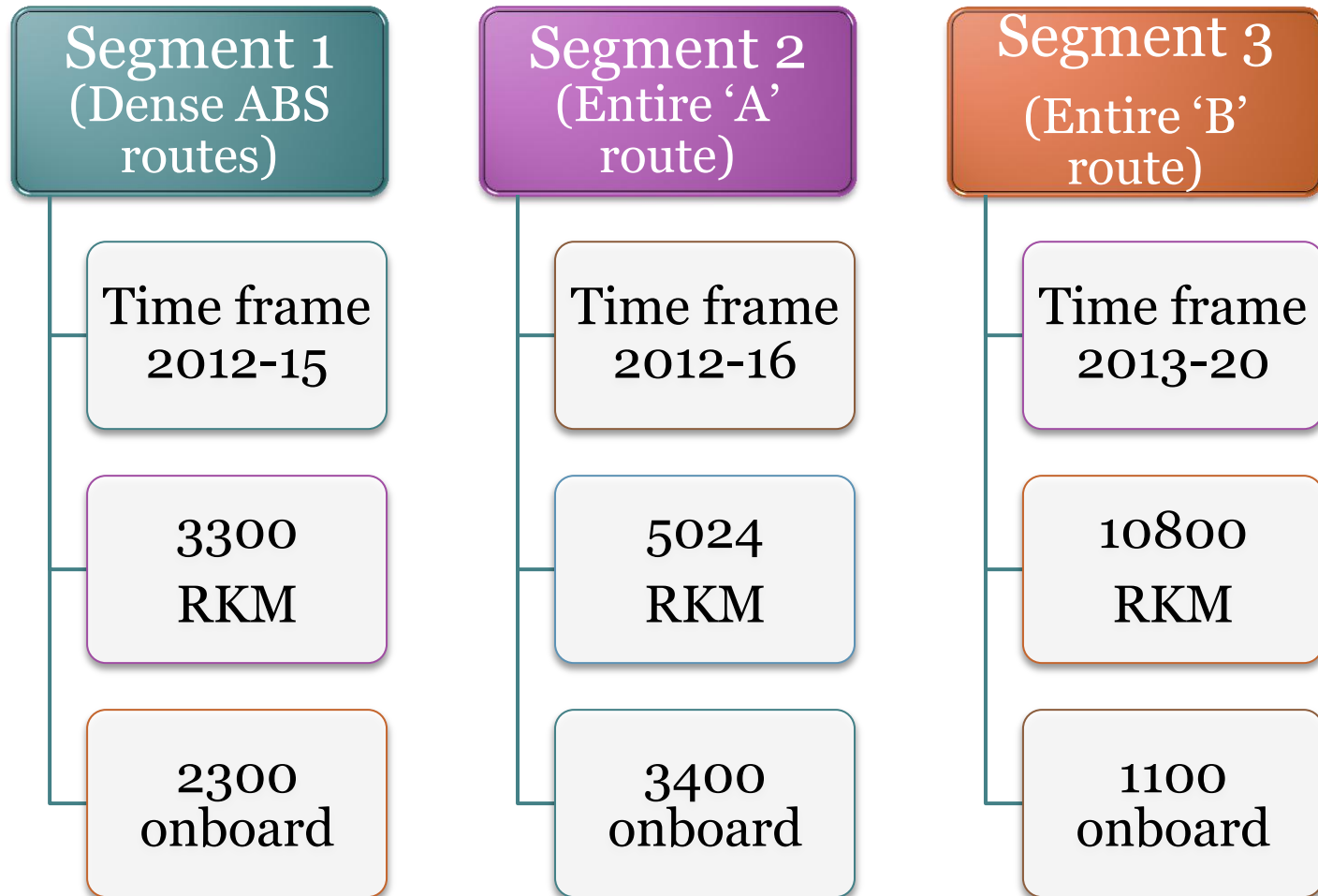- Simplified procedure for train data inputs
- Soft key technology DMI
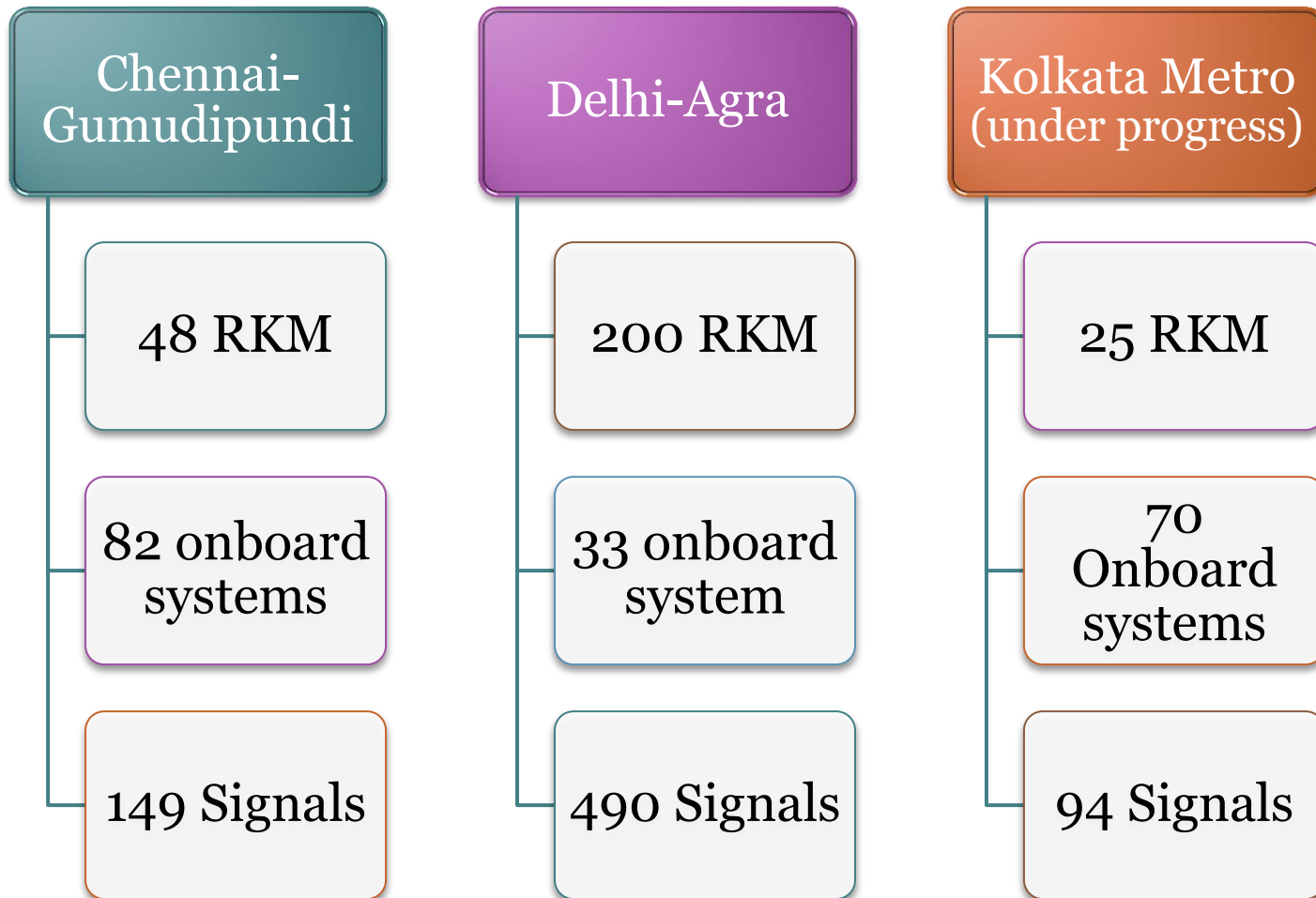- No TSR or shunt interface currently
- Preferably No infill loop
- Preferably No Doppler radar
- Preferably No JRU

Roadmap

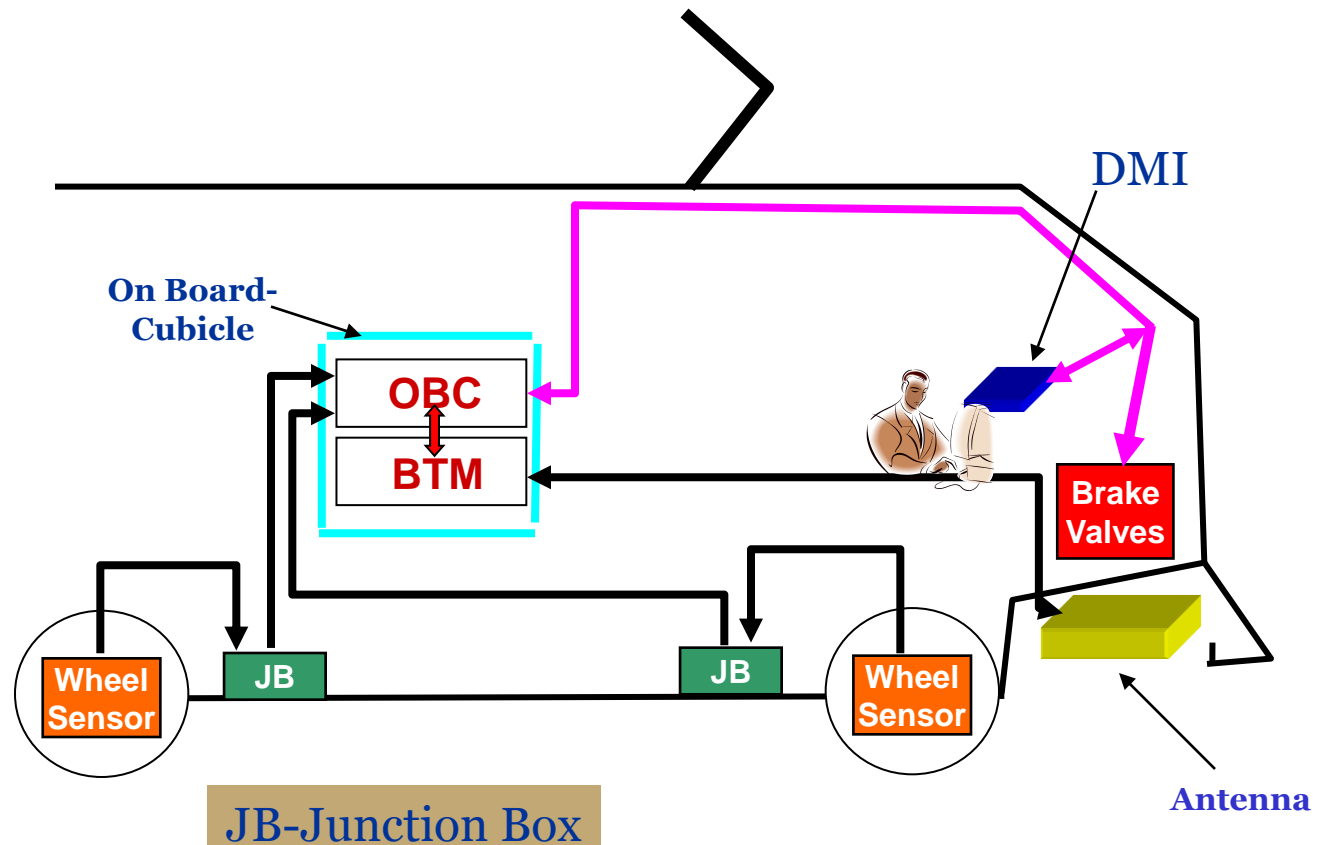| Segment 1 (Dense ABS routes)	Segment 2 (Entire 'A' route)	Segment 3 (Entire 'B' route)
Time frame 2012-15	Time frame 2012-16	Time frame 2013-20
3300 RKM	5024 RKM	10800 RKM
2300 onboard	3400 onboard	1100 onboard

Current implementations

Chennai-Gumudipundi	Delhi-Agra	Kolkata Metro (under progress)
48 RKM	200 RKM	25 RKM
82 onboard systems	33 onboard system	70 Onboard systems
149 Signals	490 Signals	94 Signals

Typical Onboard implementation

DMI

On Board-Cubicle

OBC

BTM

Brake Valves

Wheel Sensor

JB

JB

Wheel Sensor

Antenna

JB-Junction Box

OBC-On Board Computer

BTM-Balise Transmission Module

Typical Trackside implementation

Existing Signal

LEU Cabinet

Existing Signal Location Box

A

CO

Infill Balise

Data Cable

JB

e

JB

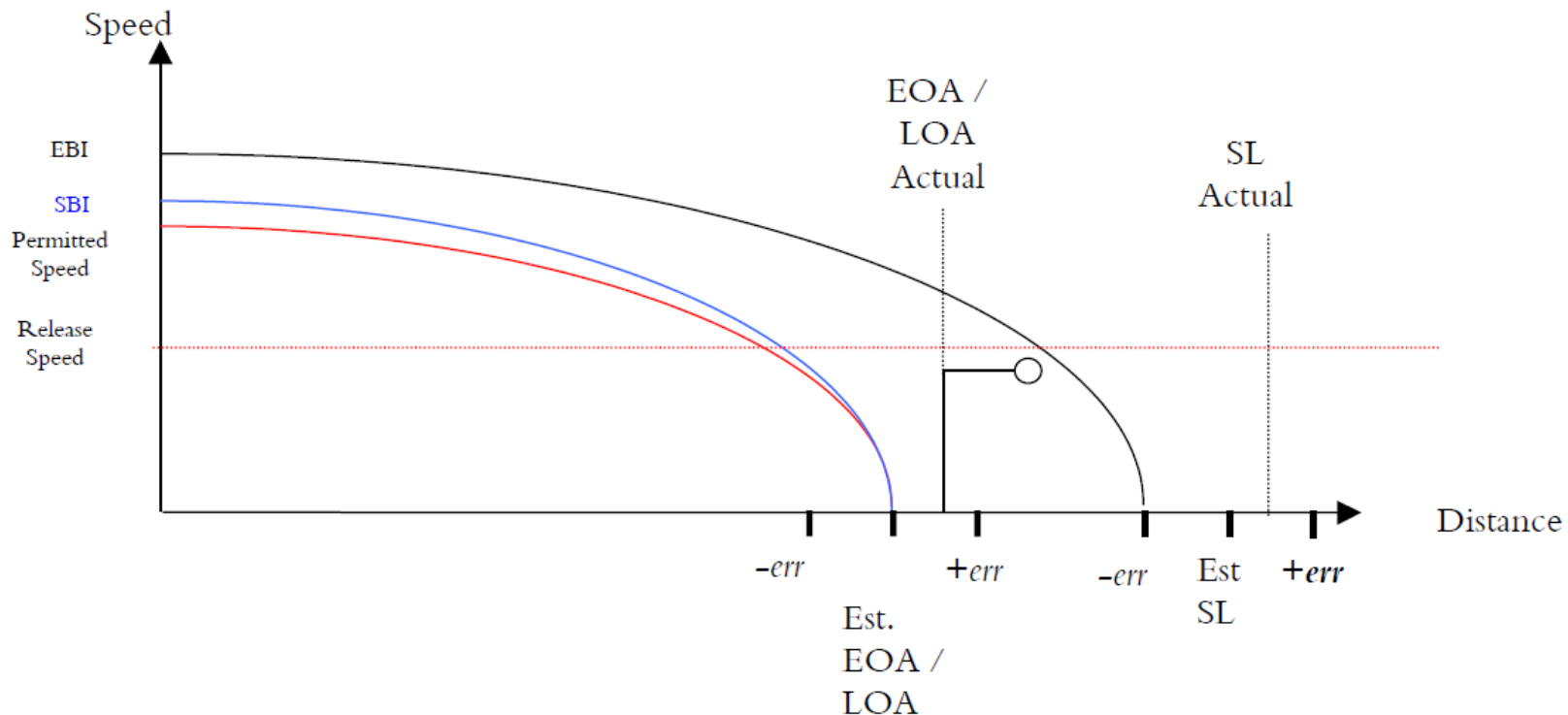e

e

Fixed Balise

Switchable Balise

Continuous speed vs distance supervision

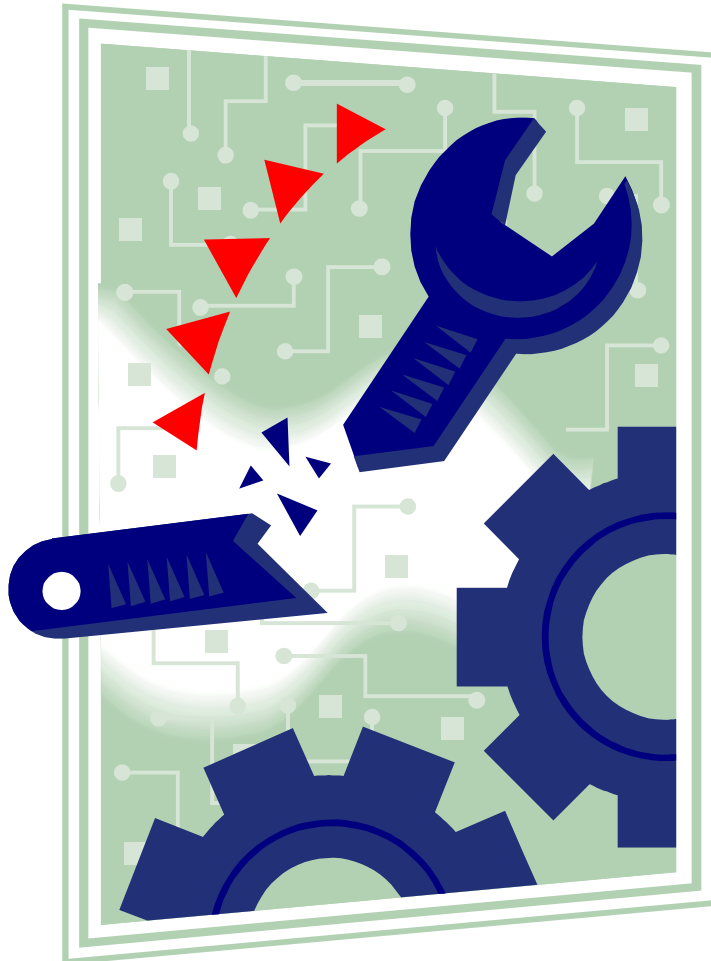Proactive monitoring of movement authority

Two levels of intervention, SB & EB

EB takes into account of odometry errors (failsafe)

Braking characteristics of trains decide SB & EB

Lessons learnt

EMI
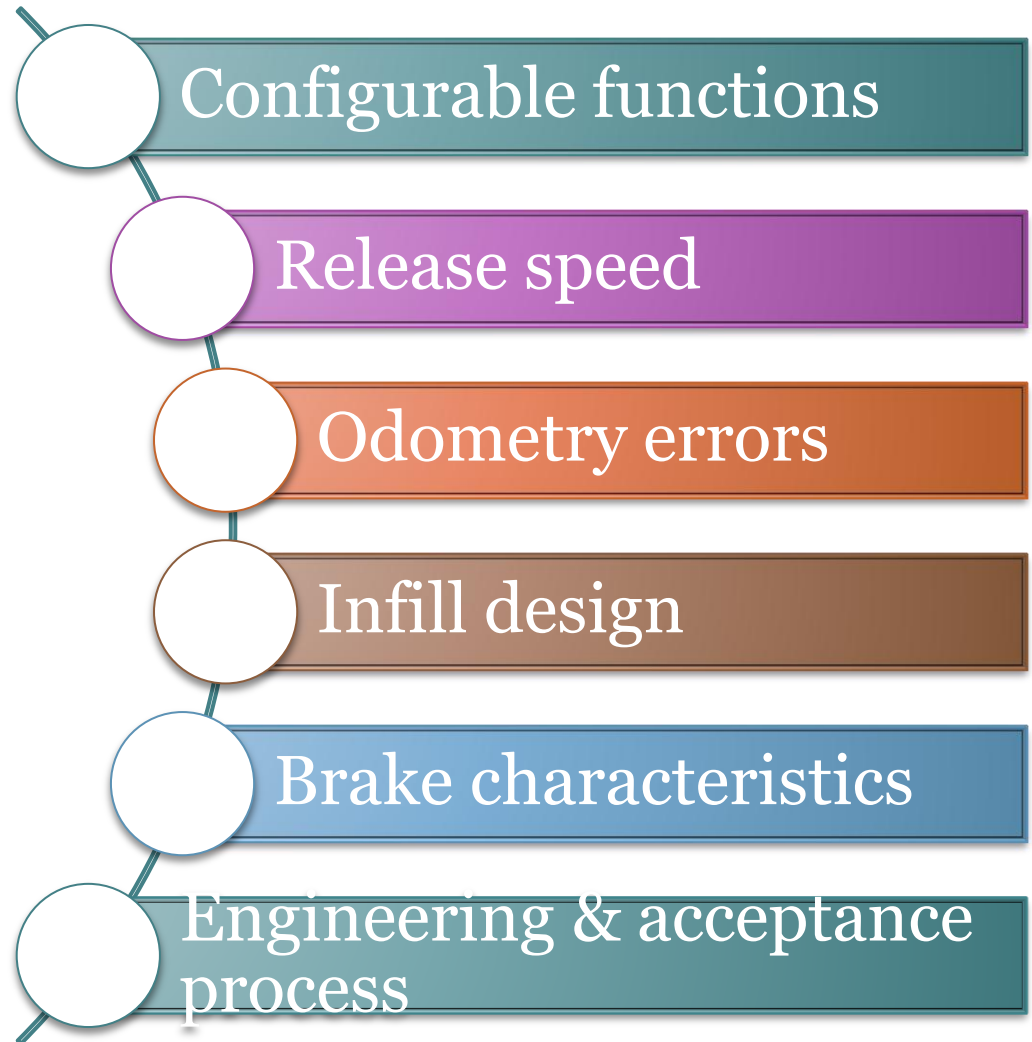
Software Errors

Power quality
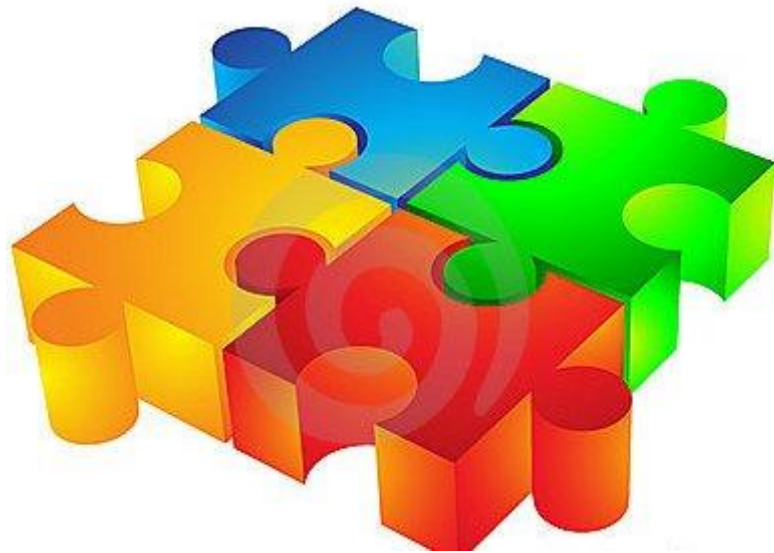
Environment

Signalling interface

Onboard interfaces

Training

Application Design & Engineering aspects

- Configurable functions
- Release speed
- Odometry errors
- Infill design
- Brake characteristics
- Engineering & acceptance process

Configurable functions

Large number of configurable functions

Configuration by assigning values to variables

Based on safety & performance considerations, and

Based on existing signalling/ operational practices

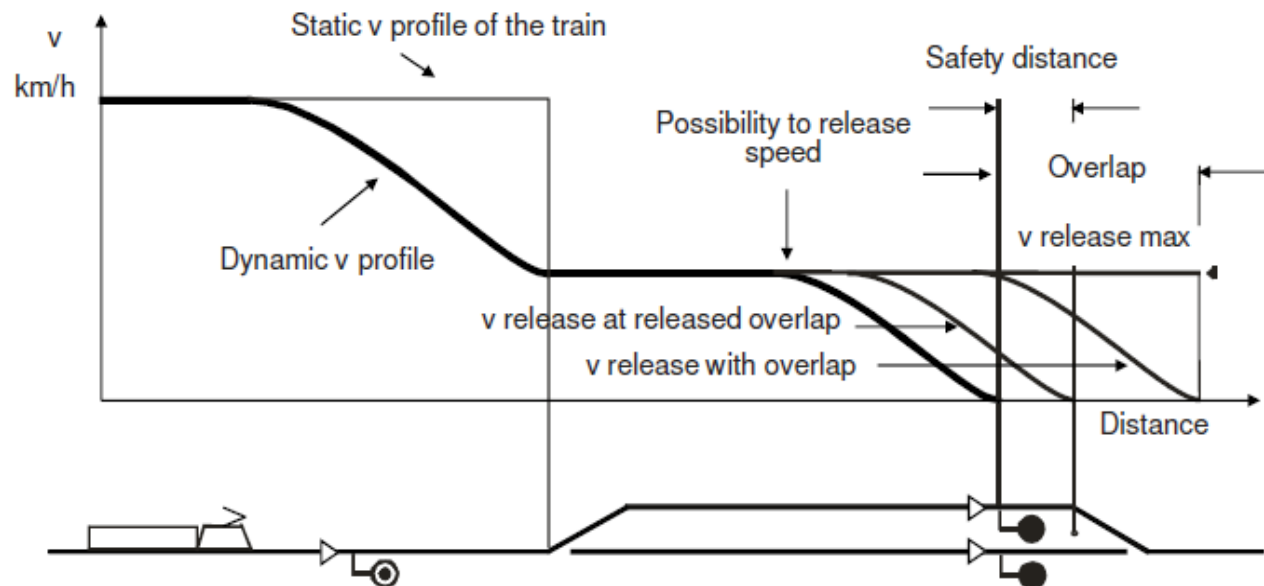|	
D_NVOVTRP	• Max distance to run in trip override mode
D_NVPOTRP	• Max distance for reversing after a trip
D_NVSTFF	• Max distance permitted in SR mode
Q_LINKREACTION	• Reaction during linking error

Table of Recommended values for variables

Parameter	Recomended value	Min Value	Max value	Default Value
D_NVOVTRP	60 m	0 cm	327.670 km	200 m
D_NVPOTRP	0 cm	0 cm	327.670 km	200 m
V_NVALLOWOVTRP	30 kmph	0 kmph	600 kmph	0 kmph
T_NVOVTRP	255 seconds	0 seconds	255 seconds	60 seconds
V_NVSUPOVTRP	30 kmph	0 kmph	600 kmph	30 kmph
Q_LINKREACTION	01 Service brake	N/A	N/A	
Q_NVEMRRLS	0 Rel at standstill	N/A	N/A	0 Rel at standstill
D_NVROLL	2 m	0 cm	327.670 km	2 m
D_NVSTFF	Infinity	0 cm	327.670 km	32767-infinity
V_NVSTFF	130 kmph	0 kmph	600 kmph	40 kmph
V_NVSHUNT	15 kmph	0 kmph	600 kmph	30 kmph
V_NVUNFIT	130 kmph	0 kmph	600 kmph	100 kmph
V_NVONSIGHT	15 kmph	0 kmph	600 kmph	30 kmph

Release speed options

Release speed calculation
- Onboard
- Trackside
- National value

Onboard method gives the flexibility of monitoring both normal and released overlap (using onboard OL timeout) up to danger point.
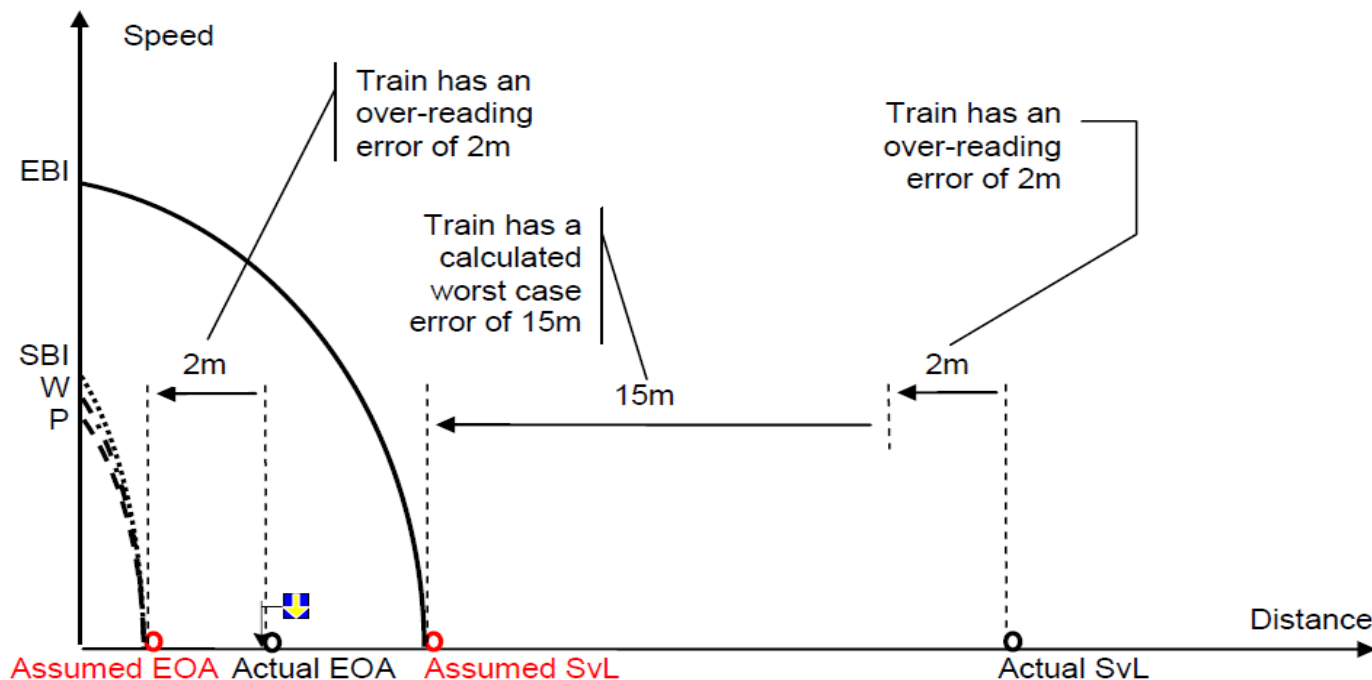

v km/h — Static v profile of the train — Dynamic v profile — Possibility to release speed — Safety distance — Overlap — v release max — v release at released overlap — v release with overlap — Distance

Odometry Errors

Safety of EB depends on odometry accuracy for speed and distance

Permitted <(5% of travel distance from last reference)+ 5m+5m

Needs to be validated during installation for above limits

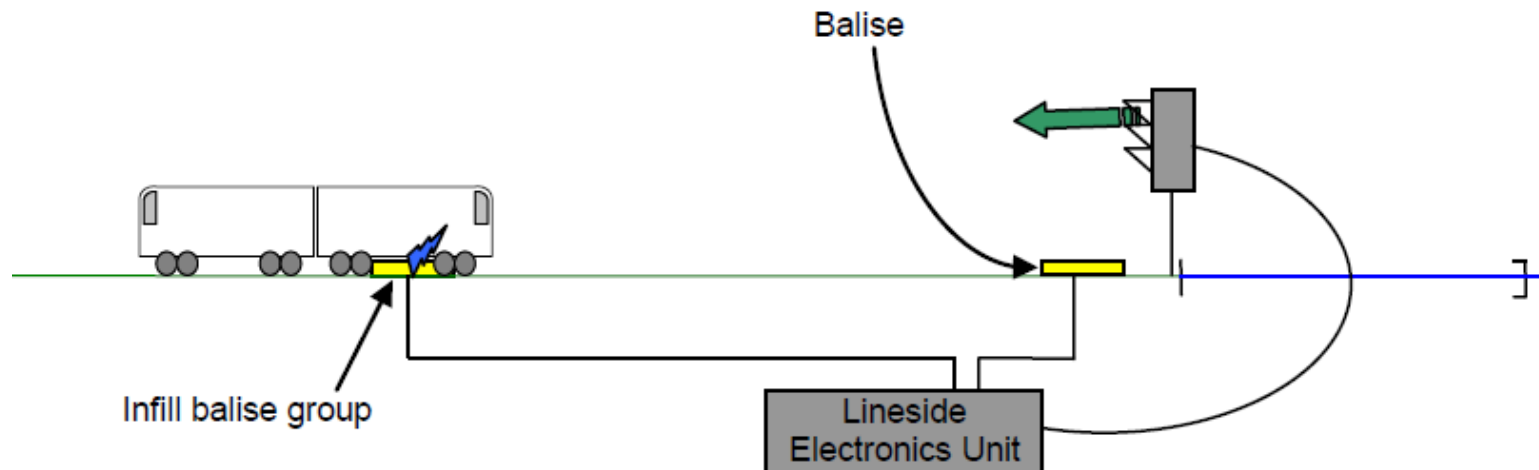Options for higher accuracy-Repositioning, Radar

Infill Design

Why infill

- Spot transmission
- Restrictive speeds near EOA
- Capacity Loss
- New odometry reference

Primarily Balise based infill to be used. Optimum position for infill will depend upon traffic characteristic on the given line.
An infill balise at 400-500m from signal provides a reasonable infill.

Balise

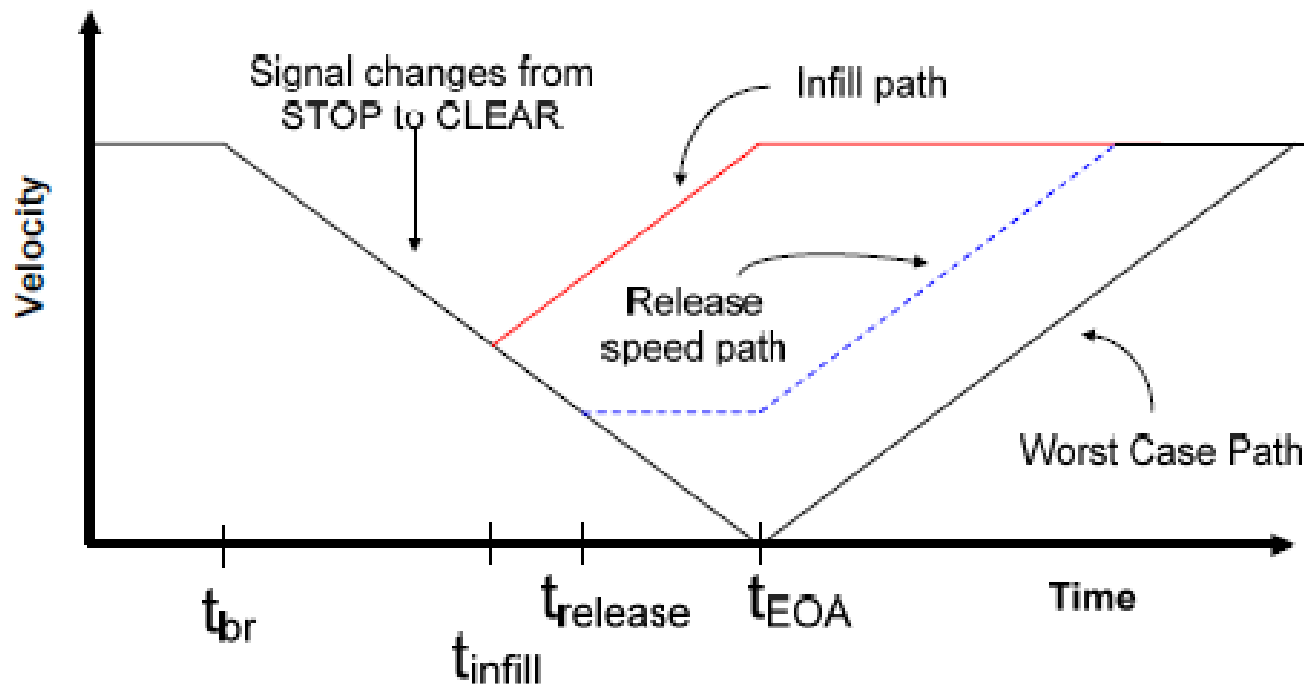Infill balise group

Lineside Electronics Unit

Release speed assists Infill function

Infill balise placed at sighting point

No braking below release speed if new MA not recd at infill

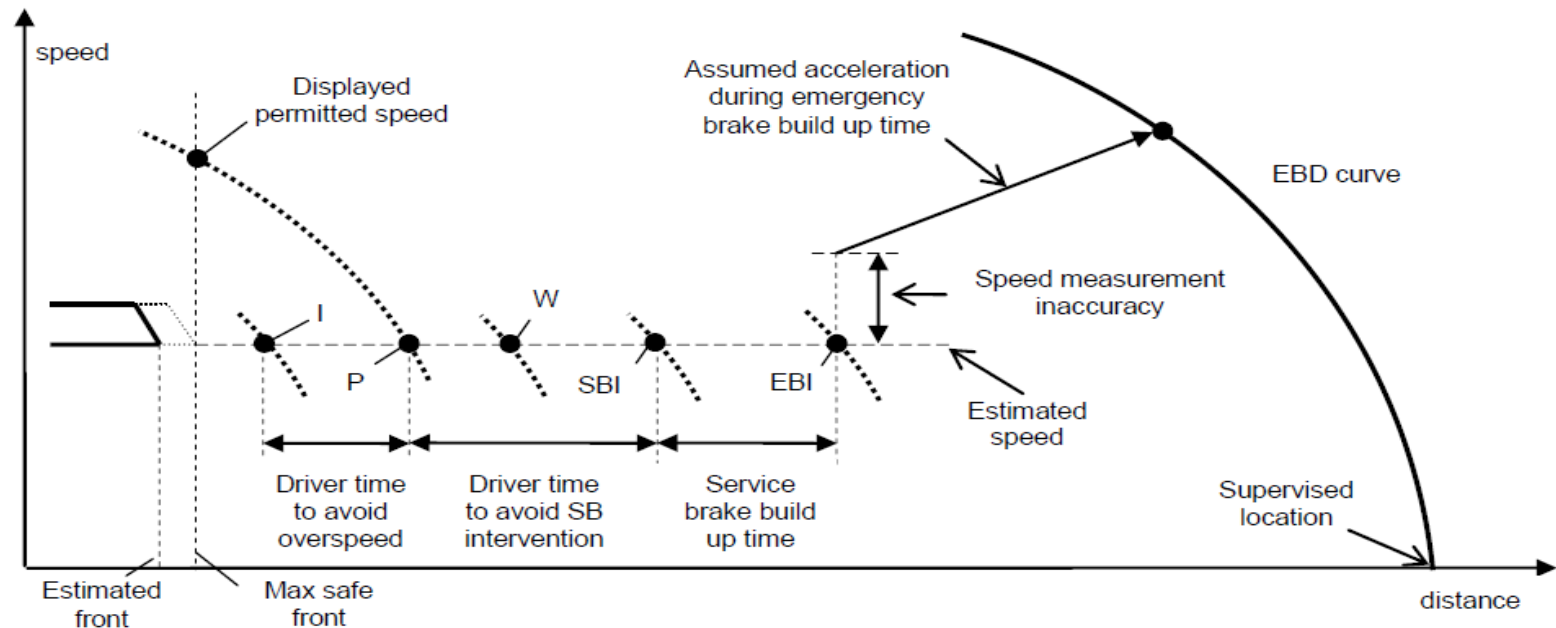RS covers the probability of signal clearance after passing the infill balise

Thus providing almost continuous infill.

Brake characteristics data

The responsibility of the ETCS being solely to command the emergency brake in due time, the overall safety of a railway system highly relies on the fact that the trains will be effectively braked according to the predicted EBD.

For SBI we have to determine a service braking model that has an acceptable residual safety risk whilst having no material impact on the way a driver controls their train.

Application Engineering processes

TPWS is a data-driven system, it is of the utmost importance that the data held by both the ETCS trackside equipment and ETCS onboard equipment is correct and up-to-date. This requires robust procedures to ensure:

Raw information is measured accurately

Raw data is transposed accurately into a form used by ETCS equipment

Transposed data is correctly entered into ETCS equipment

Data is stored securely with appropriate safeguards, change control and records management

Changes to infrastructure are promptly reflected in the data held by ETCS equipment.

Work @ RDSO-Filling the gaps in processes, tools & guidelines

Braking parameters for SB & EB for various train consists

Development of universal Brake Interface Unit

Fitment options for onboard system on space constraint locomotives

Application engineering guidelines

Variables and their recommended values,

Maintenance regimes,

V&V processes for system acceptance

Simulator for testing,

Simulator for training

Thank You

Back up slides

Issue 1- EMI

Symptoms	DMI failures, BTM failures, TIU failures, Booting failures, speed jumping on dial
Solutions	•Many of the connecting cables onboard were replaced by shielded twisted pair •Free wheeling diodes were provided across relay and brake valve coils •Relocation of Traction control relay •Body to Bogie bonding

Issue 2- Software

Symptoms	Unwarranted brake applications during mode change to unfitted
Identification of Solutions	•Data for such failures was analysed and found that there was an issue with the software where EVC does not provide acknowledgement request for mode change resulting into brake application •This was happening during second mode change to unfitted in a mission •Software is getting modified to overcome this issue.

Issue 3- Power quality

Symptoms	DMI blanking, DMI audio port failures, LEU errors due to momentary power interruption
Identification of Solutions	•Power supply filter was provided for DMI to avoid blanking •LEU power supply backup with UPS •Condenser banks were provided for LEU power supply

Issue 4- Onboard interface

Symptoms	BTM failures, TIU failures, Odometry failures
Identification of Solutions	•Removal of antenna protection plates that were causing reflections, update of BTM software, replacement of Tx cards •Modification of TIU software and replacement of cables by STP •Software modifications for odometry card and periodic sensor maintenance

Issue 5- Environmental issues

Symptoms	LEU failures (placed in a field location box)
Identification of Solutions	• Environmental conditions of dust, rain and high temperatures caused LEU failures • Location box design was modified with provision of dual metal wall with air cooling and ventilation.

Issue 6- Signalling interface related issue

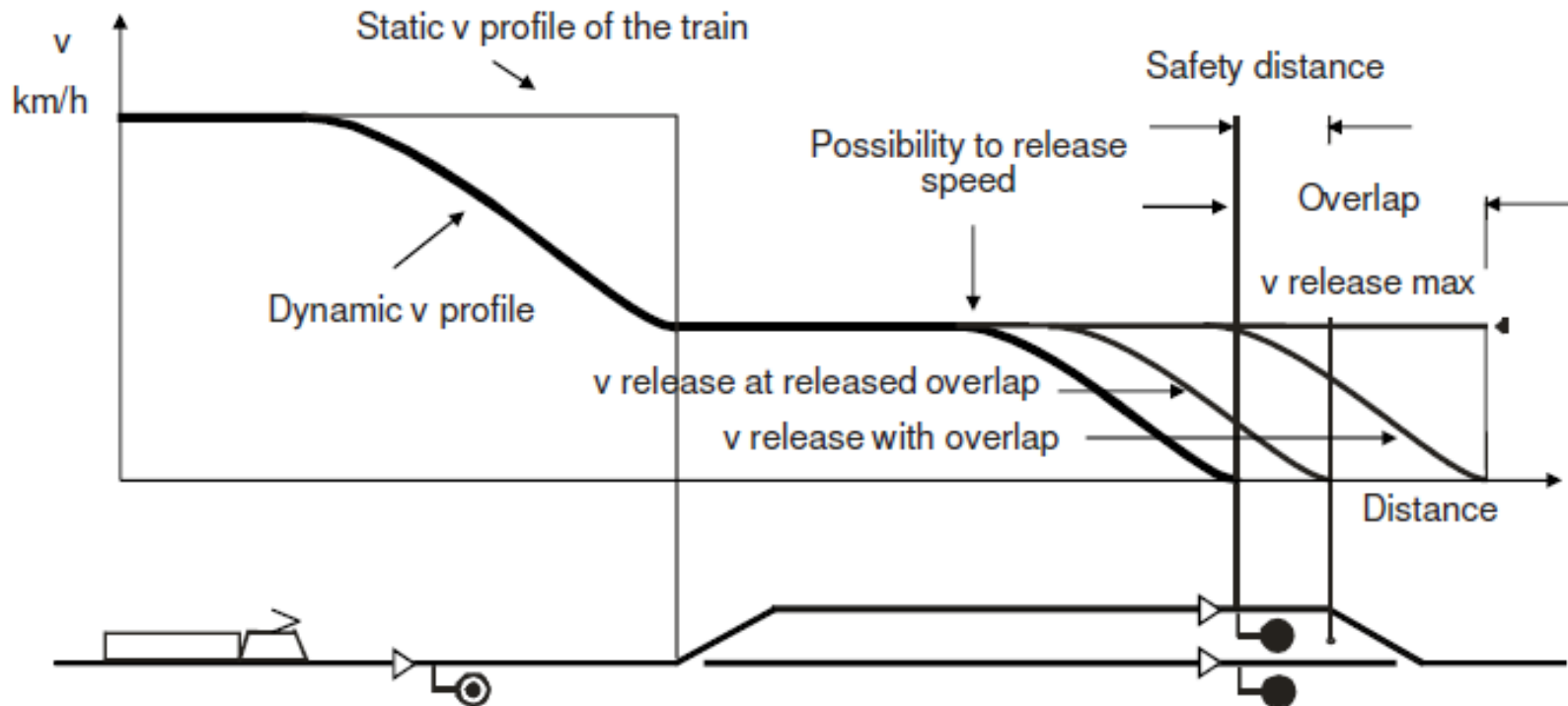| Symptoms	Unwanted braking even when train is under control as per signal aspect
Identification of Solutions	•Top point lie information is not available at signal in rear of home, so main and loop line reception curve are same upto next balise resulting in braking for a train being received on main line. •Taking top point information to signal in rear for providing correct information to onboard system

Issue 7- onboard fitment issue

Symptoms	Space constraint on certain loco types
Identification of Solutions	•These locomotives have been assessed for availability of space and it would appear that onboard system need to be fitted in 3-4 places as sufficient space is not available at a single place. •Suppliers have been shown these locomotives and been asked to submit their designs for such locomotives duly splitting the onboard system if required.

Issue 8- Training issues

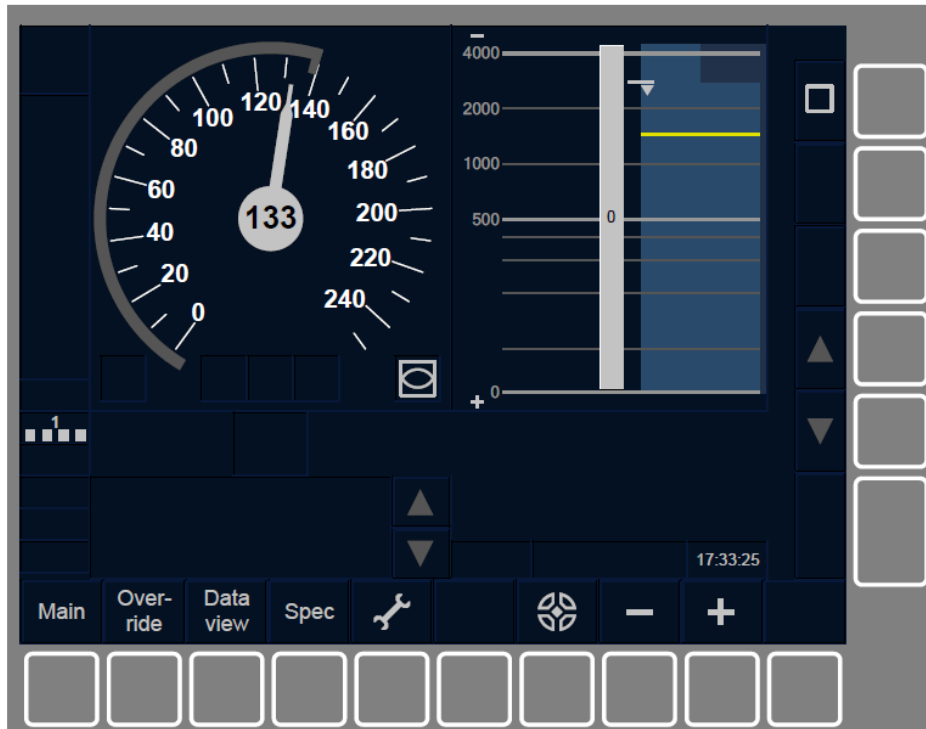| Symptoms	Loco pilots isolating the system due to lack of training
Identification of Solutions	•Since TPWS is a major change for loco pilots, they need to be properly trained to manage different mode changes, acknowledgements and DMI interface. •Simulator based training for TPWS in addition to classroom and onboard training is needed.

Release speed optimisation

An engineered release speed for cases where safe distance is less than 120m after the overlap is released and train stopping point is away from signal. (25kmph/68m, 20kmph/50m, 15kmph/30m, by using additional balise (if reqd) after normal stopping point, at (min) B/Distance before the danger point)

MMI & Data entry

IR has tried Simplified DMI and CENELEC DMI on current trials. It is now under active consideration that we shall use IRDMI that is based on soft key version of CENELEC DMI with simplification of display area by inhibiting certain areas of display not required for IR, like planning area. Since train consist is not fixed, additional train data is required to be input and validated at the start of mission. This process is currently supposed to be complex from operators perspective.

It is being evaluated to simplify this process by using fixed train types selection from drop down menu and keep to just two three steps for start of mission. Additionally, sufficient training is also being imparted to familiarise operators with all operations on DMI. This familiarity and training should lead to increase in comfort level while starting the mission.