SYSTEMWIDE

ERTMS system – A brief overview

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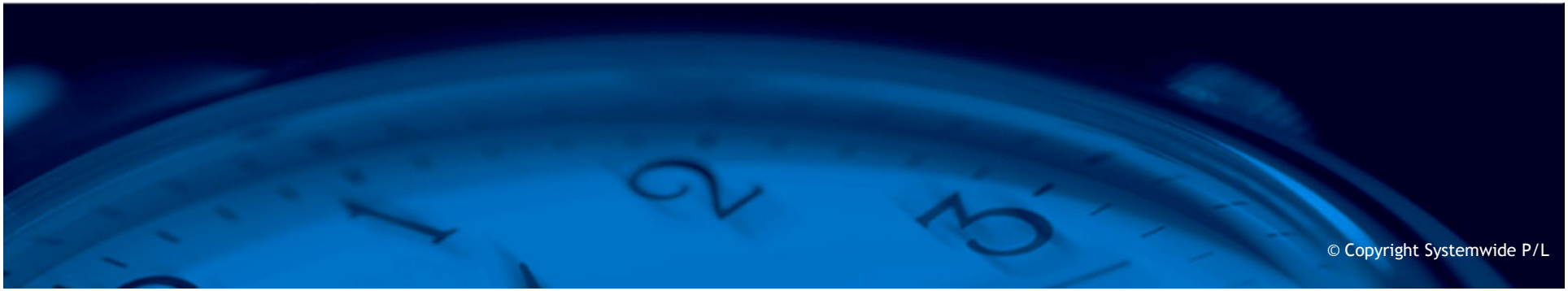
ENGINEERS AUSTRALIA

RTSA

THE INSTITUTION OF RAILWAY SIGNAL ENGINEERS INCORPORATED 1912



Index

What is ERTMS?

A platform designed in Europe to “enhance cross-border interoperability and signalling procurement by creating a single Europe-wide standard for railway signalling with the final aim of improving the competitiveness of the rail sector.”*

ERTMS
European Railway Traffic Management System

ETCS
European Train Control System

GSM-R
Global System for Mobile Communications – Railways

ETML
European Traffic Management Layer

The focus of this presentation is on the ETCS component of the system

*From http://www.uic.asso.fr/uic/spip.php?article381#

Where has ERTMS been implemented?

Level 1 and 2 systems have generally been implemented in Europe and Asia.

- ERTMS is operating or under construction in:
  - China
  - Europe
  - India
  - Mexico
  - Saudi Arabia
  - South Korea
  - Taiwan
  - Turkey
  - Australia

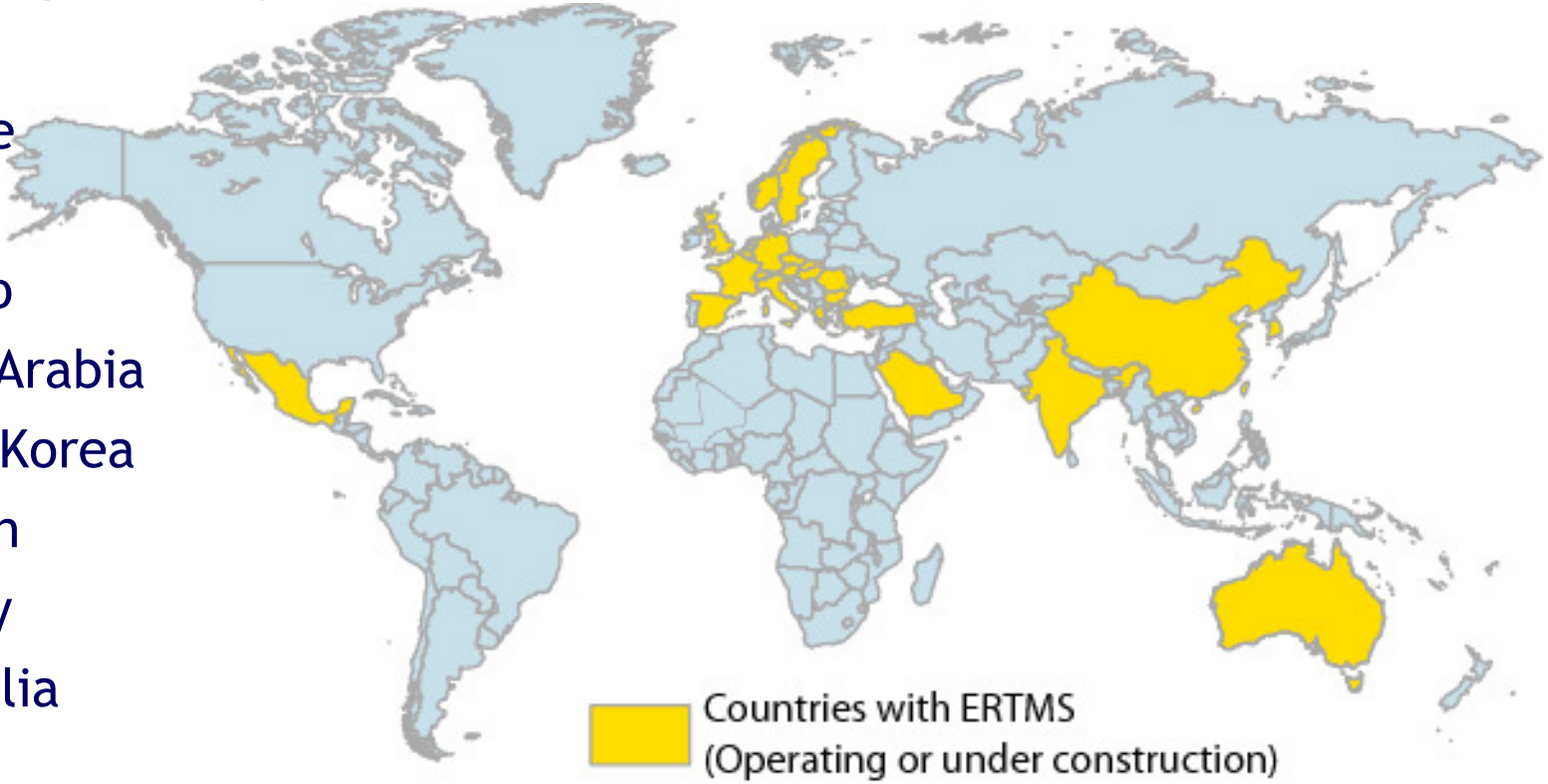


Diagram from http://www.ertms.com

What is ERTMS?

ERTMS comes in three major flavours (levels 1 – 3), and the new ERTMS Regional.

Flavour	Typical use
Level 1	Retrofitting the current system, replacing mechanical ATP, initial phases of implementation, complex junctions where radio bandwidth is limited
Level 2	Locations where GSM-R coverage is available, where signal sighting is a major constraint (eg. High-speed lines) or where removal of way-side signalling offers significant benefits
Level 3	Capacity constrained sections, typically highly sectorised operations (eg. Metro-style operation) – Currently in development
Regional (ERTMS-LC)	On regional or low traffic lines when renewing or introducing signalling equipment, where removal of way-side signalling offers significant benefits and capacity can be traded off to reduce costs.

What is ERTMS?

Level 1 systems rely on balises embedded in the track to provide updates to the train borne system about its authority to proceed.

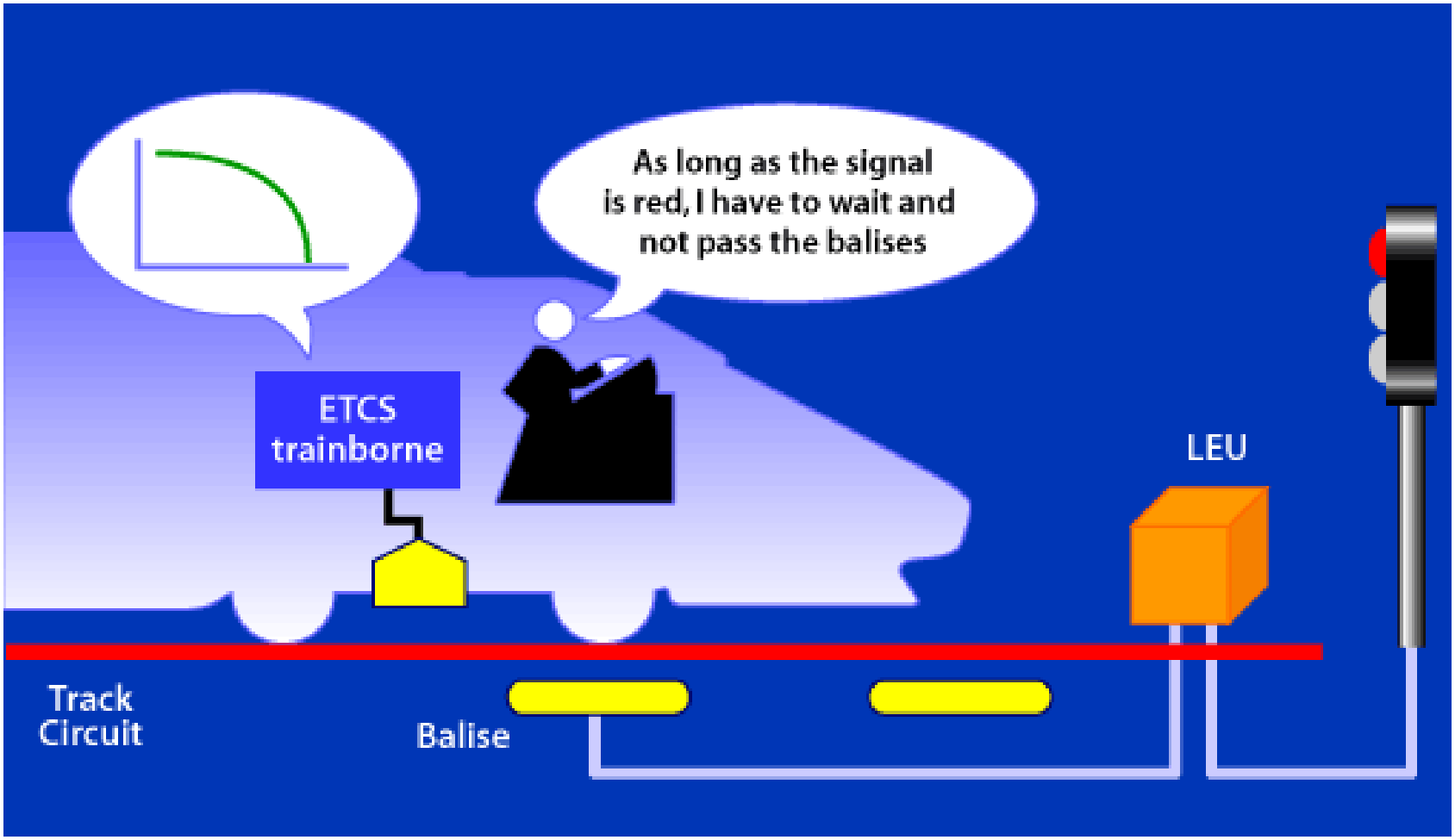


Diagram from http://www.ertms.com

What is ERTMS?

Level 2 systems use a radio-link to provide updated authorities to the train on a near-continuous basis. The system relies on balises to update the train position with balises demarking positions and track circuits tracking train location for the interlocking.

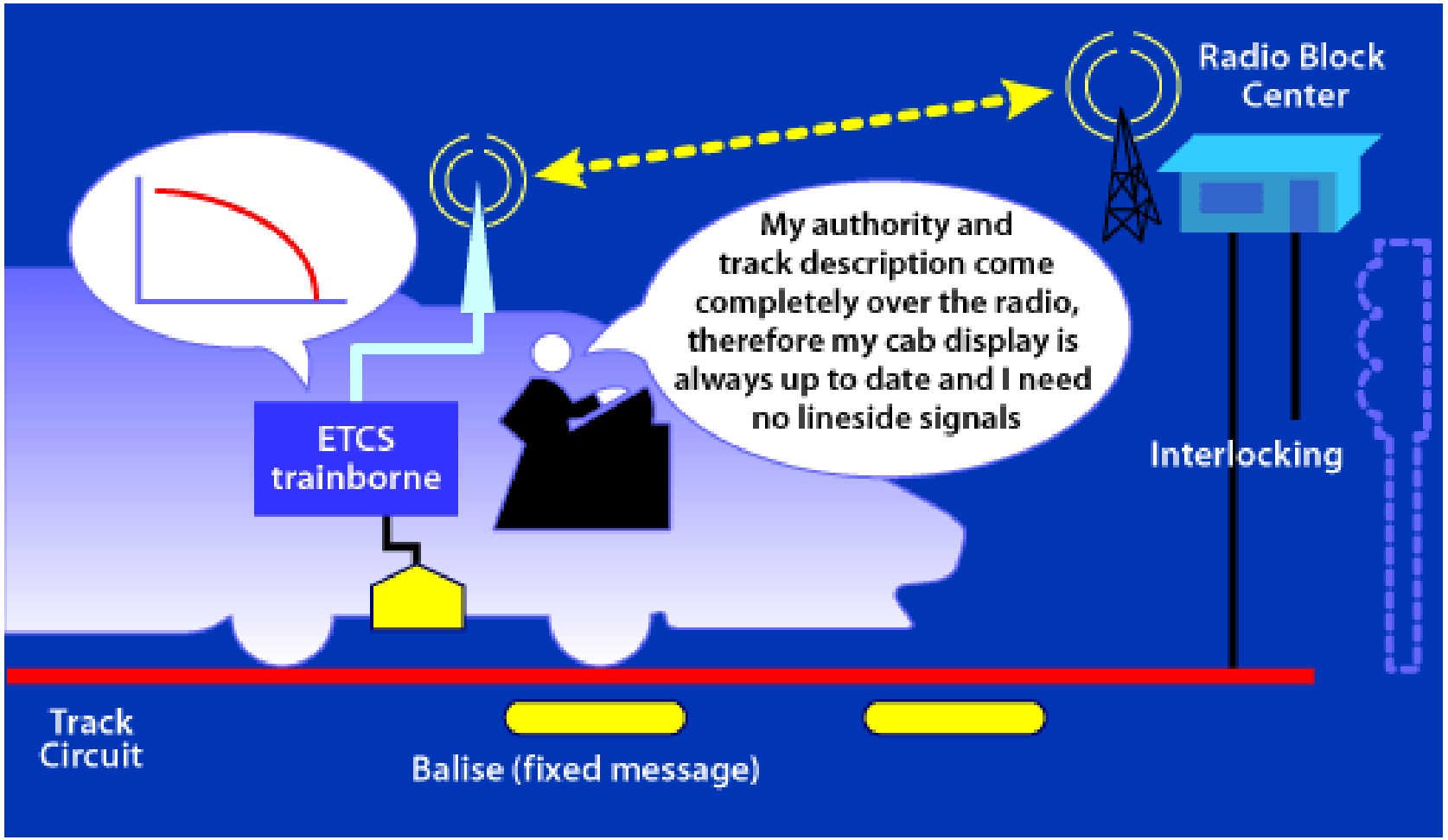


Diagram from http://www.ertms.com

What is ERTMS?

Level 3 is a moving block system with the train integrity on board. The train relies on balises to update position only, transmitting position and integrity data back to the interlocking via GSM-R link. This level is in a conceptual phase.

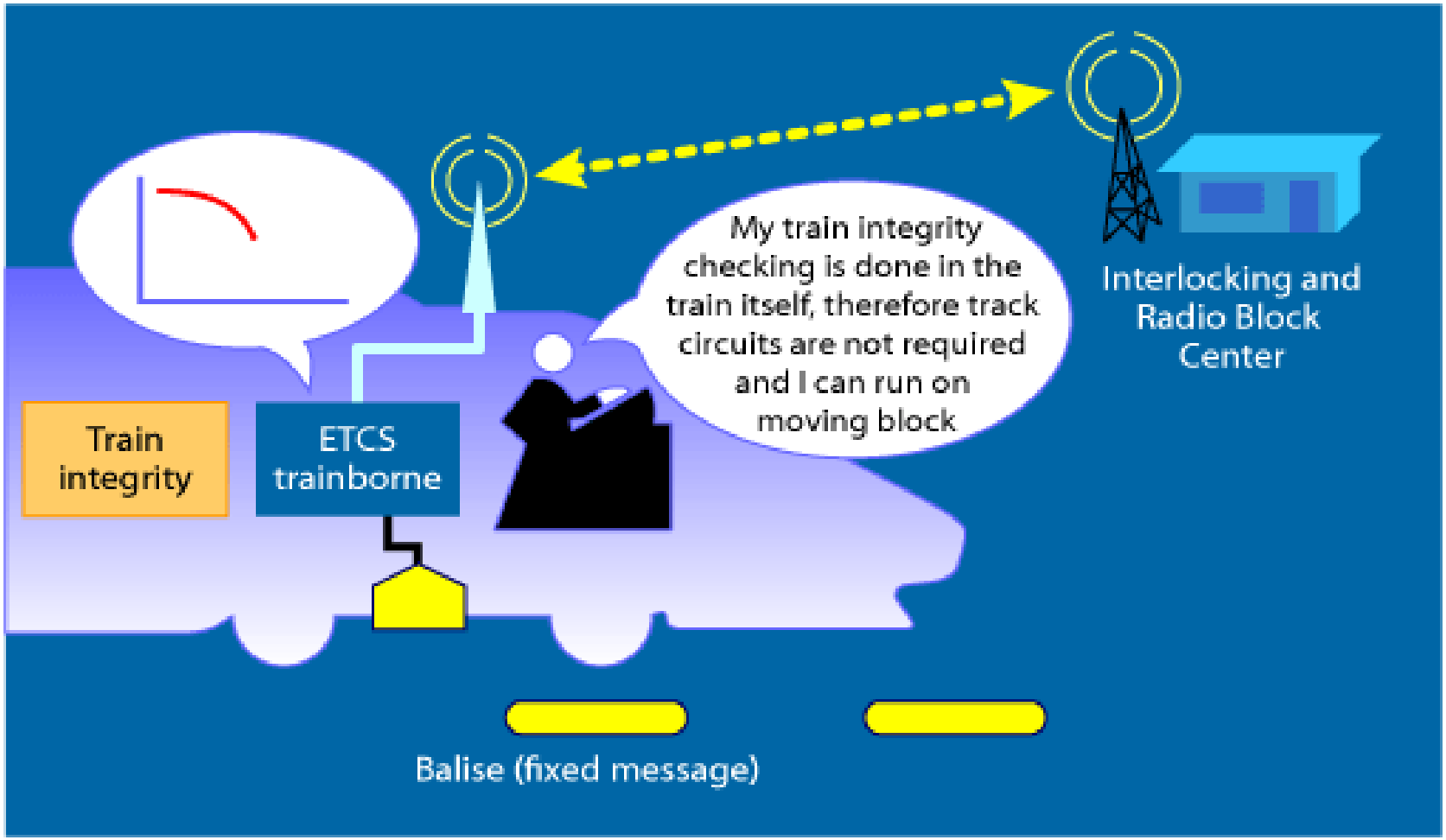


Diagram from http://www.ertms.com

What is ERTMS?

Previously known as ERTMS-Low Cost, ERTMS-Regional is based on ERTMS level 3 with a fixed block. The need for fully redundant GSM-R links are reduced, since typically traffic density is low and the effect of drop-outs will be limited.

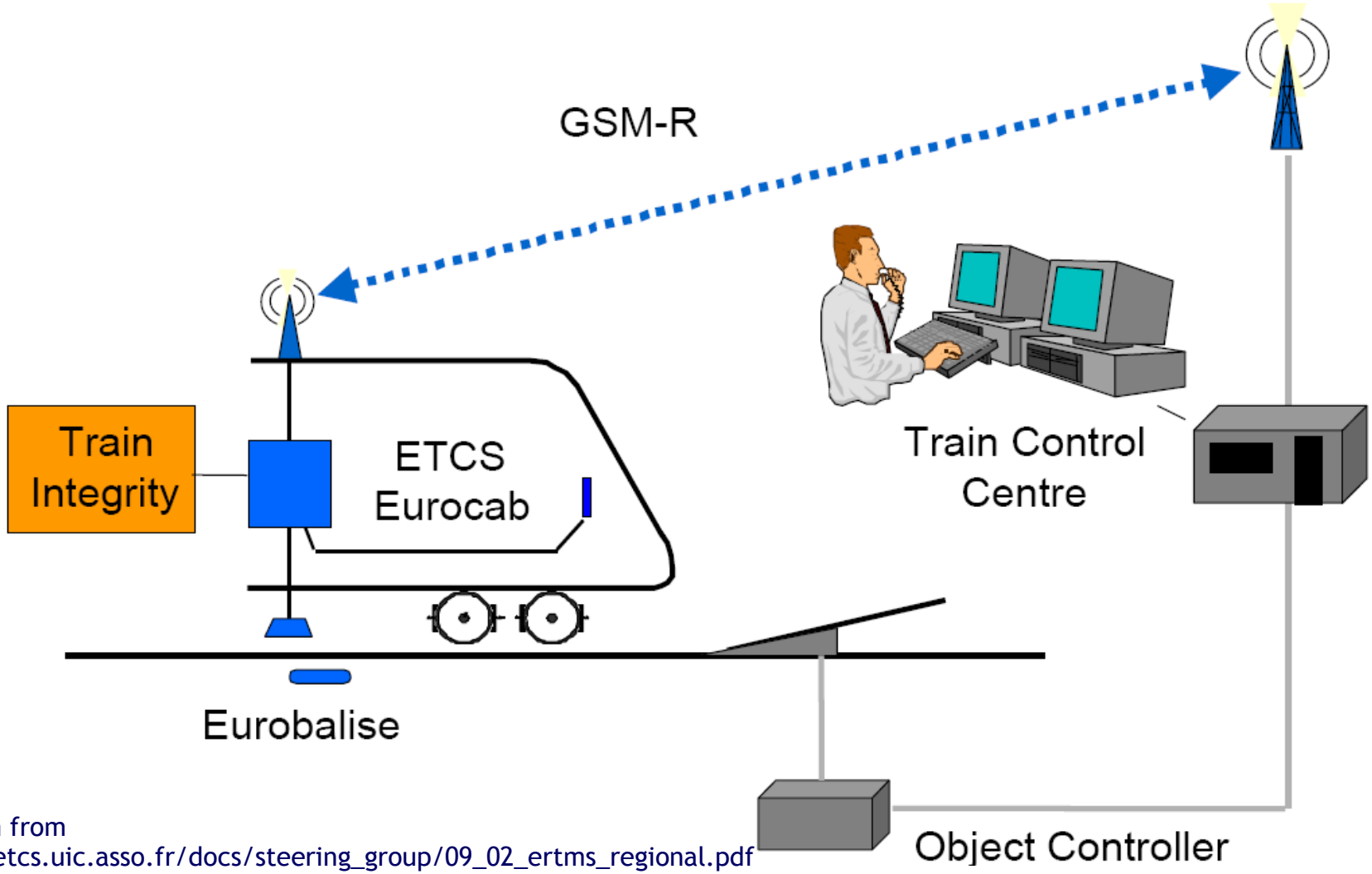


Diagram from
http://etcs.uic.asso.fr/docs/steering_group/09_02_ertms_regional.pdf

Questions?

Index

Why would ERTMS be put onto a network?

ERTMS offers benefits in four key areas.

- Increased safety
- Increased capacity
- Decreased maintenance
- Improved interoperability & reduced cost

Improved safety

In Australia ETCS / ERTMS is usually associated with providing increased safety.

- ETCS is an ACTIVE safety system, intervening before train exceeds its limit of Authority
- Includes OVERSPEEDING prevention and virtually eliminates the possibility of Signals Passed At Danger (SPADs)
- In-cab signalling improves signal sighting in poor conditions

Capacity impacts of ETCS

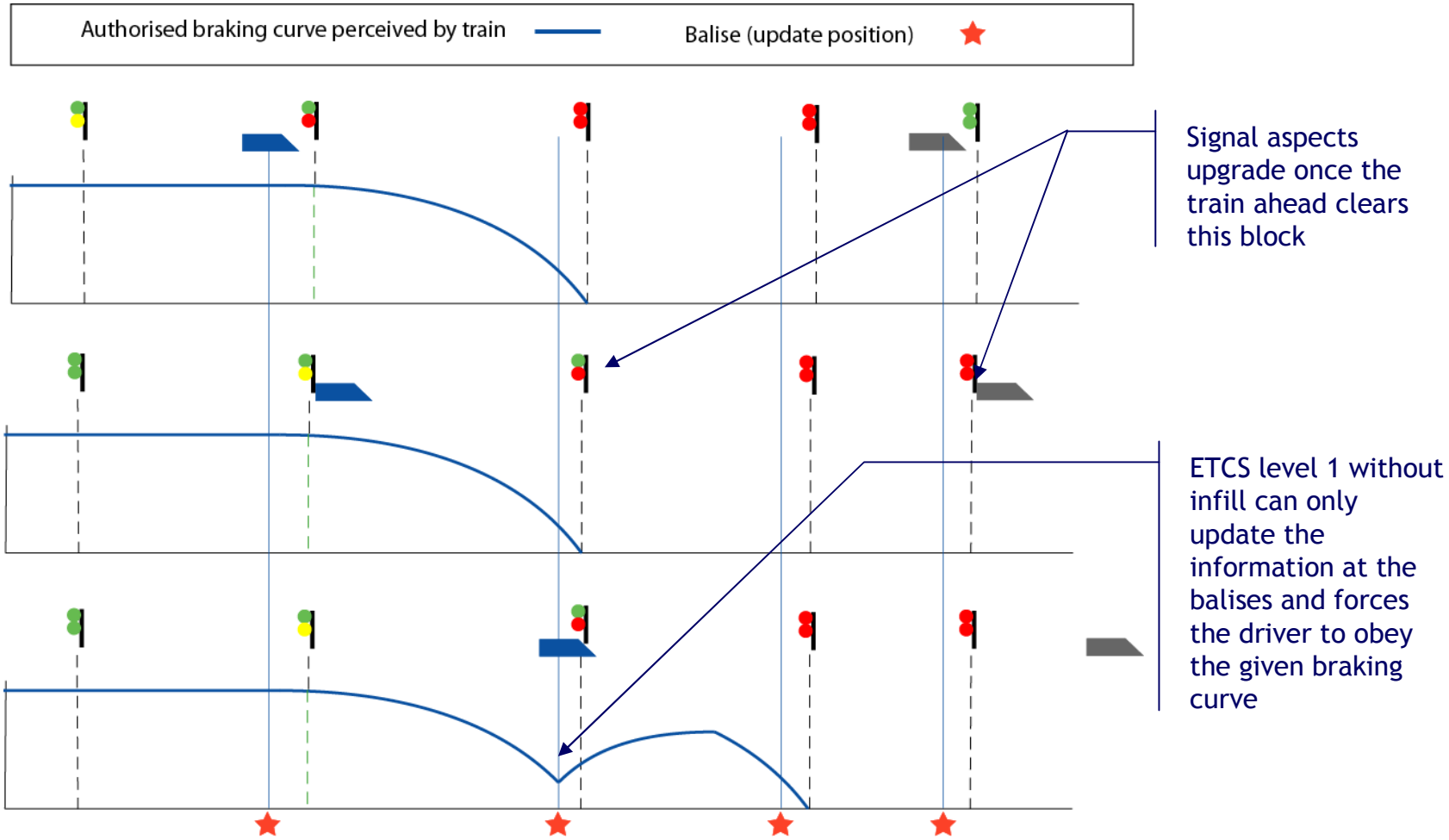
However there are also significant implications for capacity from this type of ATP system.

- ✓ Active authority enforcement provides opportunities to reduce overlaps protecting against line-speed SPADs
- ✓ Levels 2, 3 and Regional allow for in-cab displays, reducing the impacts and compromises required due to signal sighting constraints
- ✓ Shift away from way-side signalling makes smaller block lengths and additional 'aspects' more feasible
- × Additional safety factors can lead to enforcement of more conservative driving techniques
- × Infrequent authority updates can lead to reduced responsiveness to clearing aspects

Capacity impact – Level 1 without infill

ETCS level 1 systems will continue to enforce a braking curve until the next balise is reached, even if the track ahead clears before this time. If adequate infill is not provided, the delay in updating the system is likely to reduce capacity.

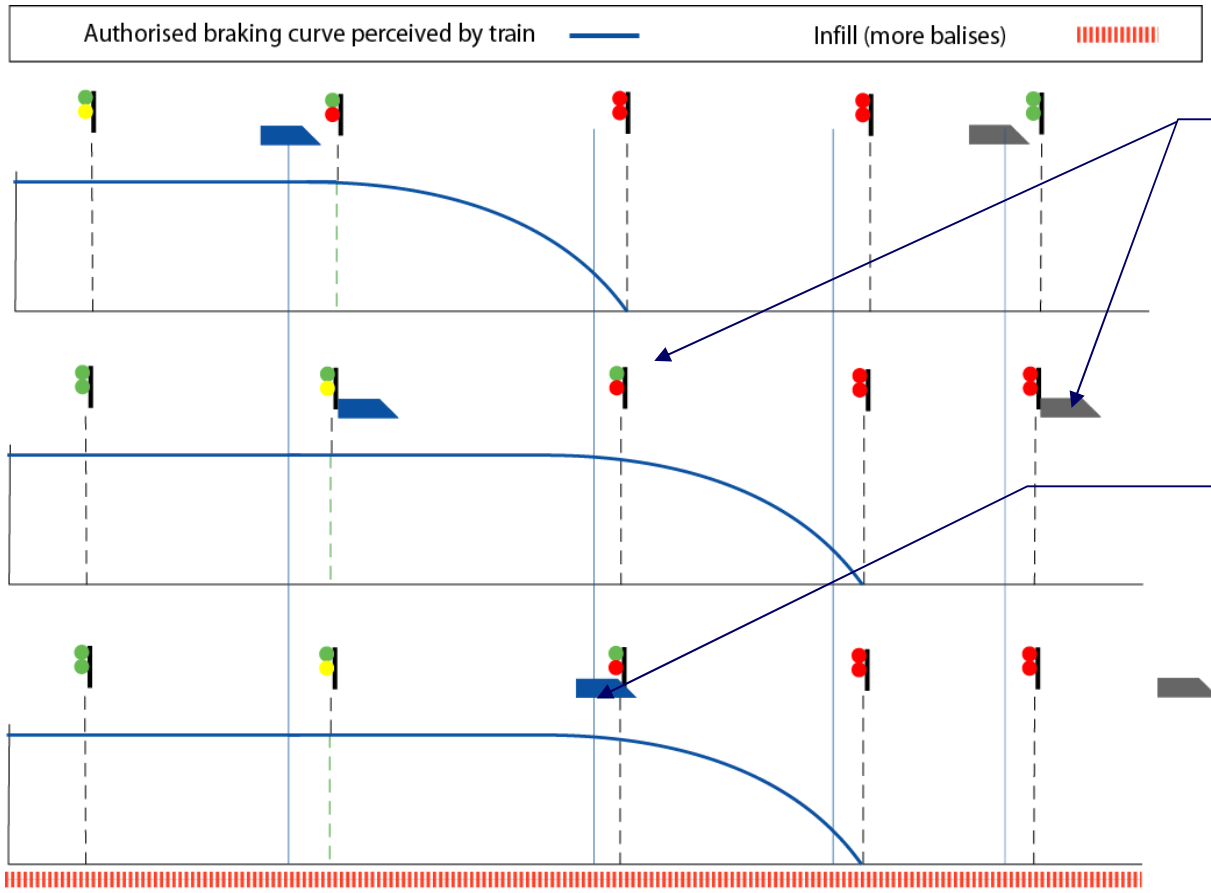
ETCS level 1 with one balise before each signal



Capacity impact – With Infill

Providing continuous or near-continuous infill will avoid this capacity degradation and could provide a net benefit where signal sighting previously limited the ability of the driver to respond to an upgraded aspects.

ETCS level 1 with infill



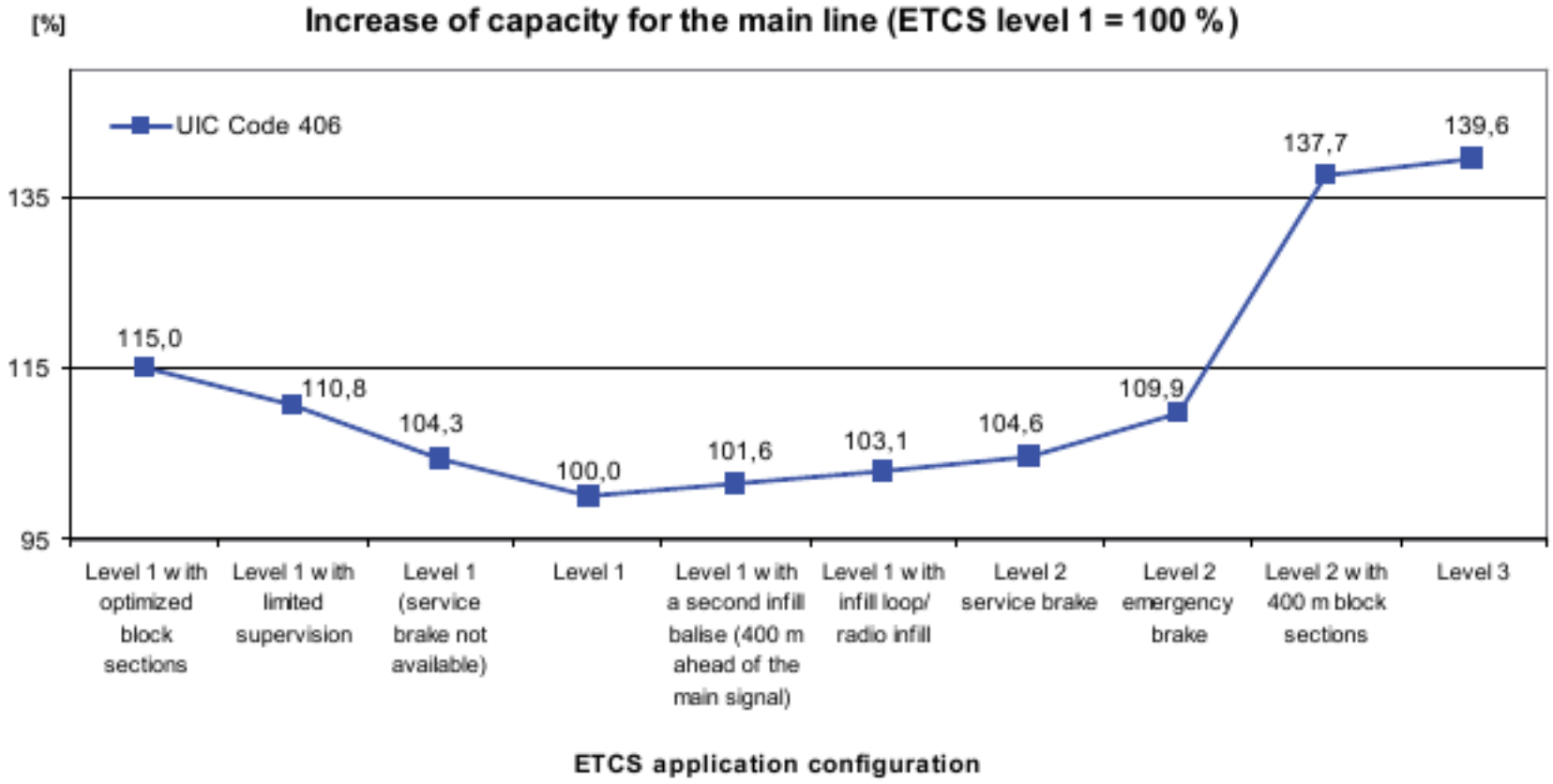
Signal aspects upgrade once the train ahead clears this block

ETCS level 1 with infill or level 2 with continuous infill provides updated authorities to the train on a continuous basis. Driver may even drive more aggressively since he knows the up to date authority at any time.

Note: Infill can be provided either with a radio-based (level 2) system or by providing additional balises or infill loops (level 1).

Capacity implications of ETCS implementations

A recent study undertaken for the UIC by the Verkehrswissenschaftliches Institute at the Aachen Technical College provided similar results. Compared to more limited forms of ATP, a decline in capacity to a full basic level 1 implementation is expected.



Source: Influences of ETCS on line capacity – Generic Study, UIC, 2008.

Capacity implications of ETCS - Reliability

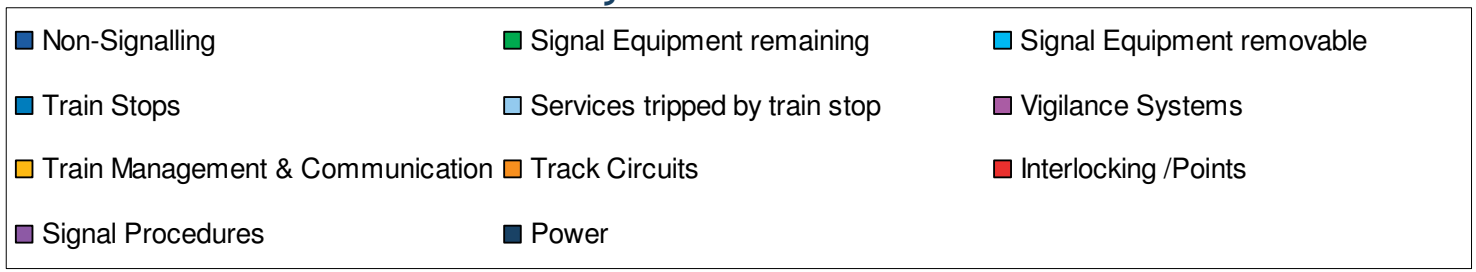
System reliability and capacity are closely linked concepts. As part of the same study, Systemwide evaluated the degree to which reducing the number of mechanical train stops or way-side signalling would be likely to improve reliability.

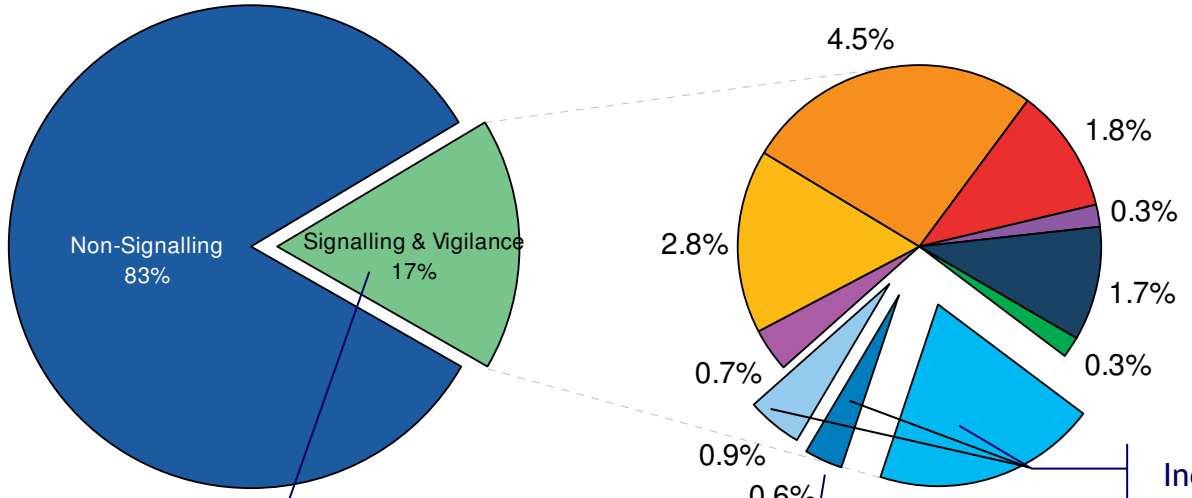
- ETCS Level 1 should provide similar levels of reliability compared to a conventional system, and with similar maintenance costs.
- ETCS Level 2 should provide reduced equipment failures, if carefully implemented with redundancy and thoroughly tested to resolve any initial problems.
- The capacity benefits of a Level 2 (communications based) system are similar to those possible with a well implemented Level 1 system.
- Reliability improvements due to a reduction in equipment failures are likely to be negligible and would most likely be offset by teething issues or disruption in implementation.

Capacity implications of ETCS - Reliability

Based on data provided for the Sydney network, the proportion of delays attributable to cause that would be removed with implementation of ETCS are minimal.

Time delayed due to incidents





Approximately 17% of current incident delay minutes are attributable to signalling and vigilance related issues

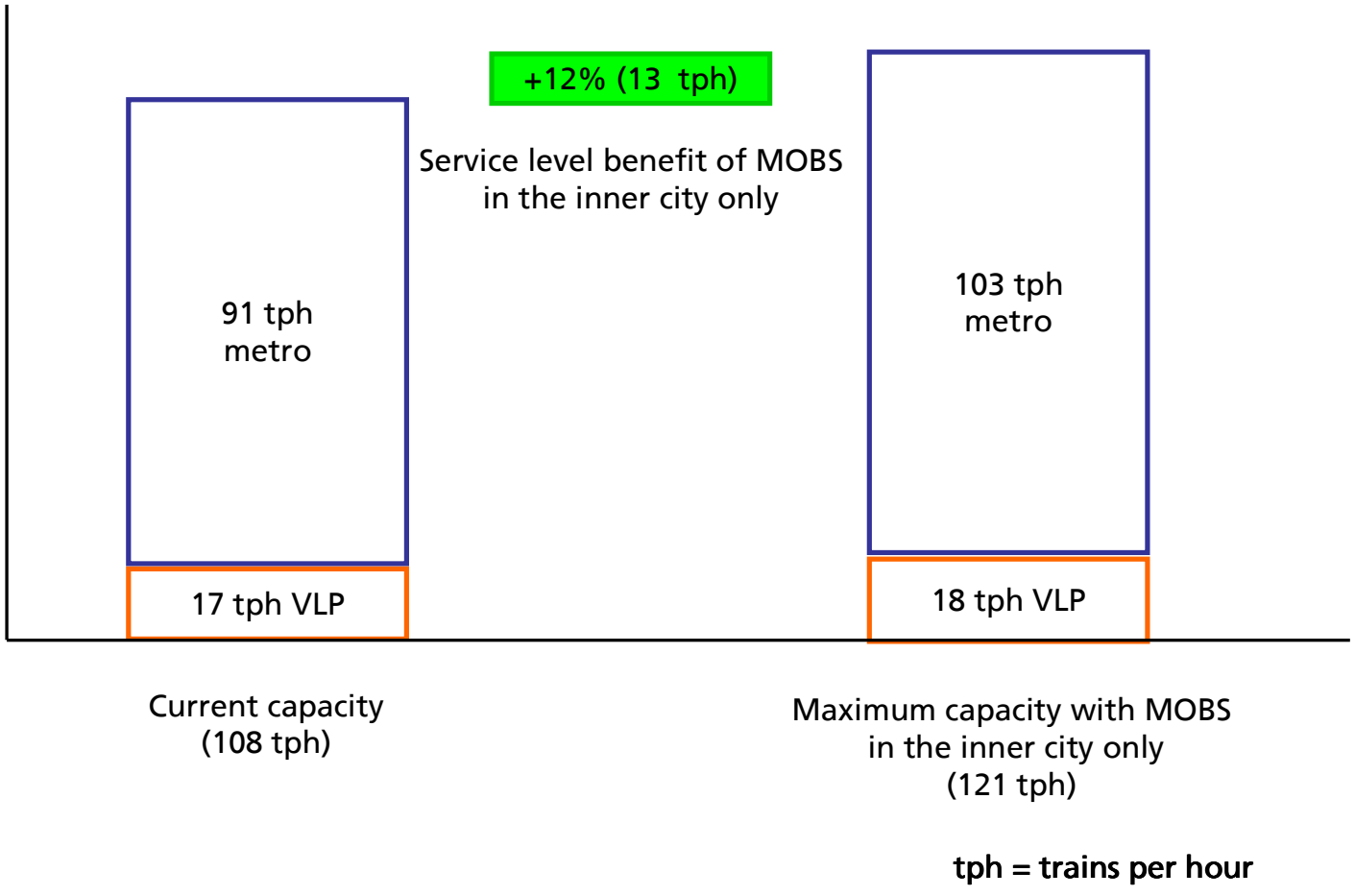
It is expected that these incidents will be replaced by an unknown number of delays attributable to ETCS related failures

Incident delay minutes due to train stop failure, train stop tripping and most signal equipment failures can be removed by implementing ETCS level 2

Capacity implications for ETCS - Melbourne

A high level study investigating the degree to which infrastructure upgrades could be deferred by implementing an advanced (near moving block) ATP solution in Melbourne was undertaken.

Number of inbound services arriving in the city during the peak hour



tph = trains per hour

Decreased maintenance

As described previously, some types of ETCS provide opportunities to remove way-side signalling which can have significant benefits in maintenance cost.

- Replacement of mechanical ATP systems reduce the scope for mechanical failures and thus reduce need for regular maintenance (eg. Train stops)
- Level 2, 3 and Regional provide opportunities to remove way-side signalling infrastructure
- However, infill loops and balises are still mounted trackside and are still susceptible to damage
- Particularly in regional applications, a move to a radio-based system such as ETCS regional could have significant benefits in reducing dependency on remote, trackside signalling infrastructure.

Interoperability benefits

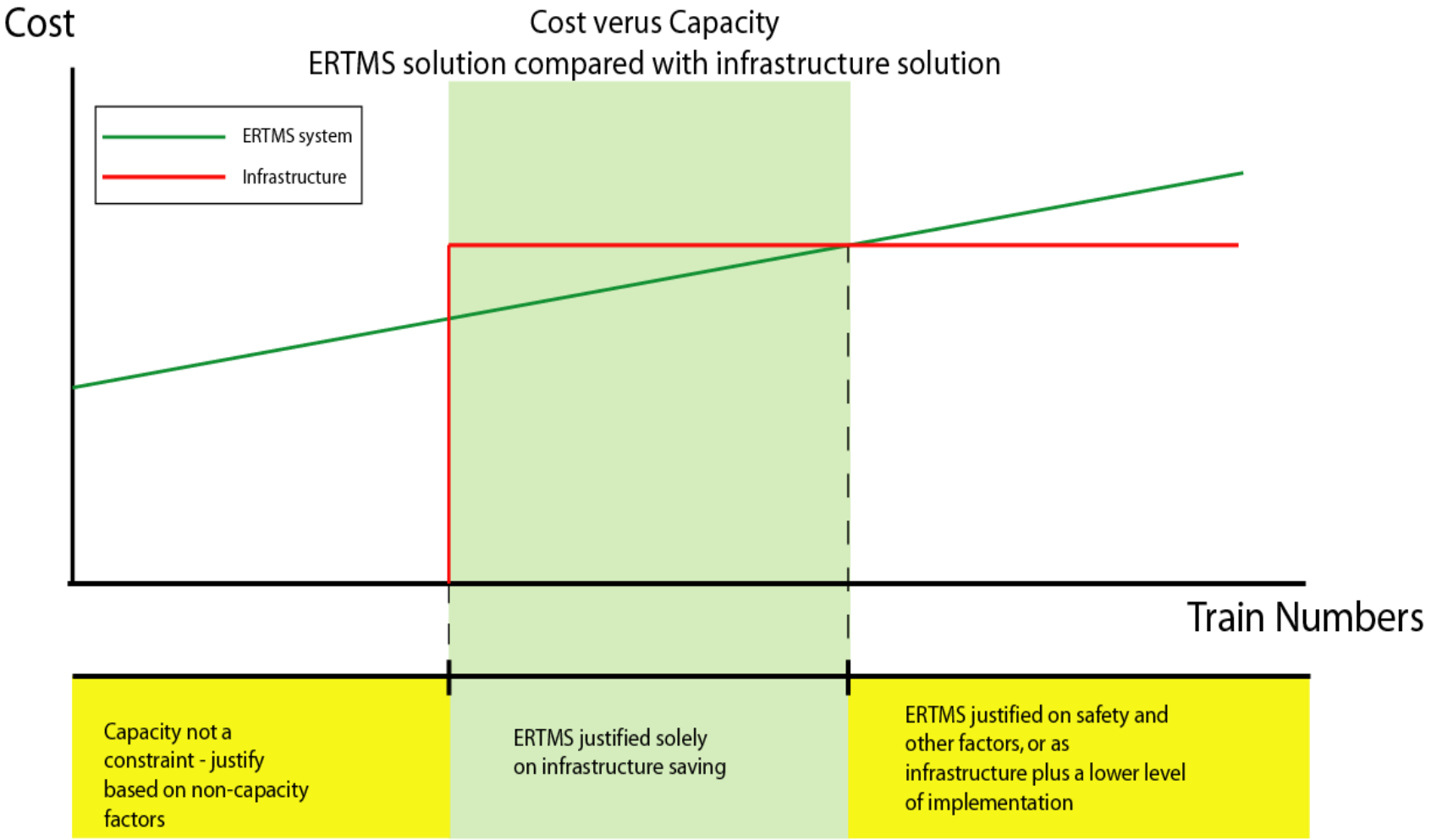
ERTMS was developed to consolidate a number of incompatible signalling systems across Europe, to allow international services to operate without requiring equipment and drivers to be able to operate under multiple safeworking systems.

- The driver for development of ERTMS in Europe was cross border interoperability
- Standardisation of systems was identified as an opportunity to reduce cost of signalling, since duplication of efforts are avoided
- Benefits associated with interoperable equipment removes risks of single-supplier solutions and also assists in transferability of skilled labour
- This is also an issue for Australia, where Queensland Rail, ARTC, and RailCorp are operating or implementing incompatible ATP systems.

Index

Developing a business case for ERTMS

Any investment needs to be justified by a business case. For ERTMS this could be based on improved safety, reduction in maintenance or supply costs, improved interoperability or capacity increases.



Developing a business case for ERTMS

These benefits have to also be traded off against potential downside of the system.

- Implementation risk.
  - ERTMS is a new technology.
  - Need to ensure system redundancies are working and initial incidents are reduced.
  - Operators may need to modify braking rates, as experience is that the default implementations are too conservative and impact significantly on performance and capacity.

- High cost
  - Significant changes will lead to significant costs.
  - System redundancies are required, particularly in Level 2 and 3 systems where redundancy is required over and above a basic GSM-R train radio communication system.

Managing implementation risk

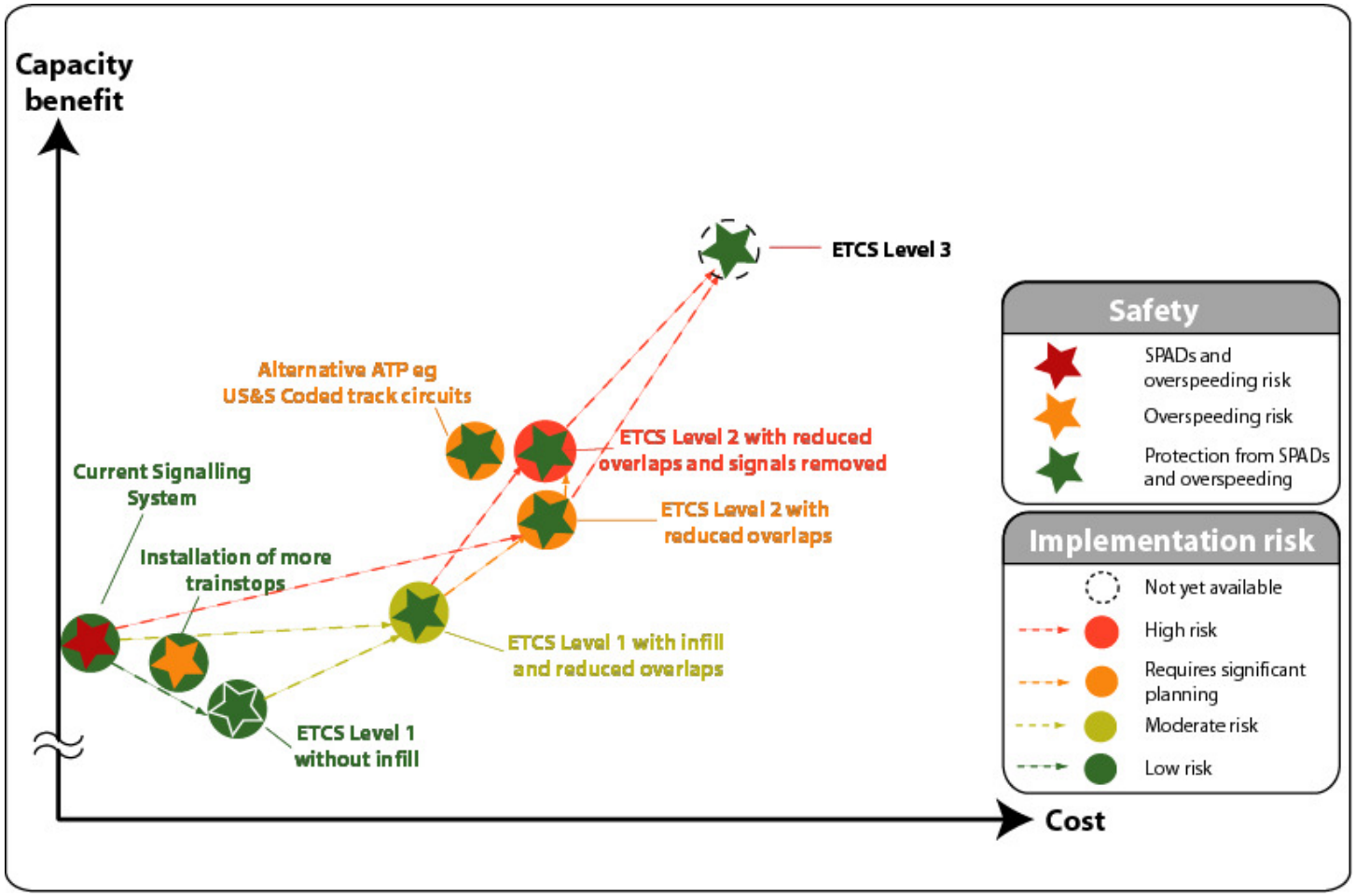
Managing these risks can be achieved by manipulating the implementation strategy.

- Geographical implementation strategy
  - RailCorp's pilot implementation is an example of where a reasonably low-traffic geographical segment was chosen for the site of the tests, to reduce the risk of major network disruption.
- By operating sector
  - Implementation of ERTMS into a single, isolated sector of the operation can have benefits in staging the rollout. Providing opportunities to upgrade only a captive fleet and only a portion of the network.
- By rollingstock type
  - Even where sectorisation isn't possible, a strategy such as has been implemented with TPWS could be used, to manage transition by fitting only new rollingstock types
- By implementation level
  - Overlaying a basic implementation on the current safeworking, then retrospectively upgrading interlocking or depreciating the use of the old safeworking.

Managing implementation risk - planning rollout

The capacity benefits, implementation risk, safety and long-term strategy should be balanced in choosing an ATP system. ERTMS is not the only system available and may not be the best choice if the only driver is improvement in safety.

Cost vs Benefit vs Implementation risk for different ATP options*



* The costs and capacity benefits in this diagram are illustrative only.

Questions?

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