



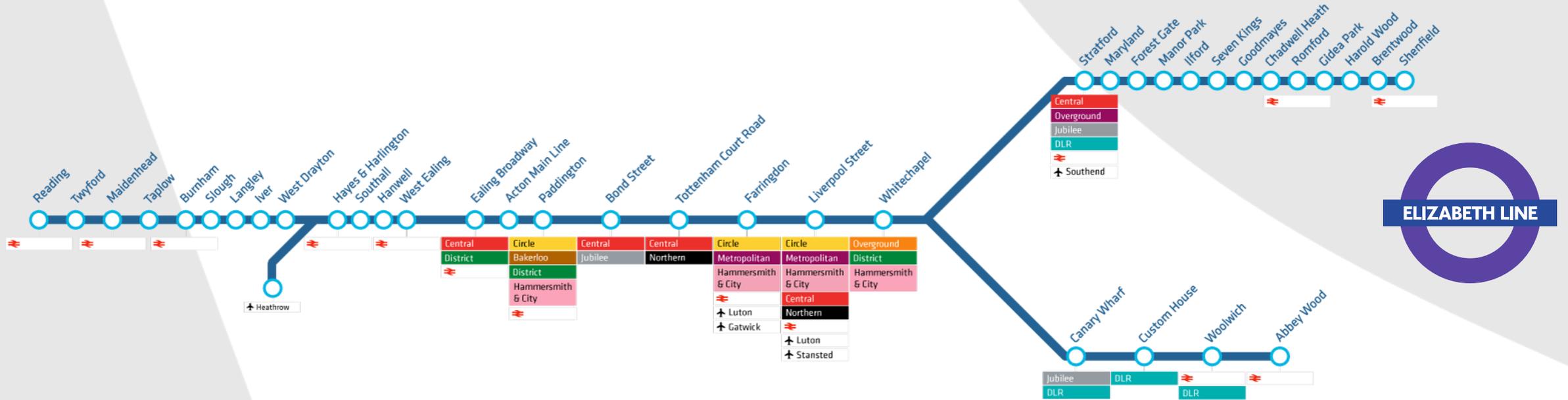
System Integration in Crossrail Lessons Learned

Pradeep Vasudev – Head of System Integration, Crossrail

Crossrail - What is the Elizabeth Line?



Crossrail - Overview



Increases London's rail capacity by 10%

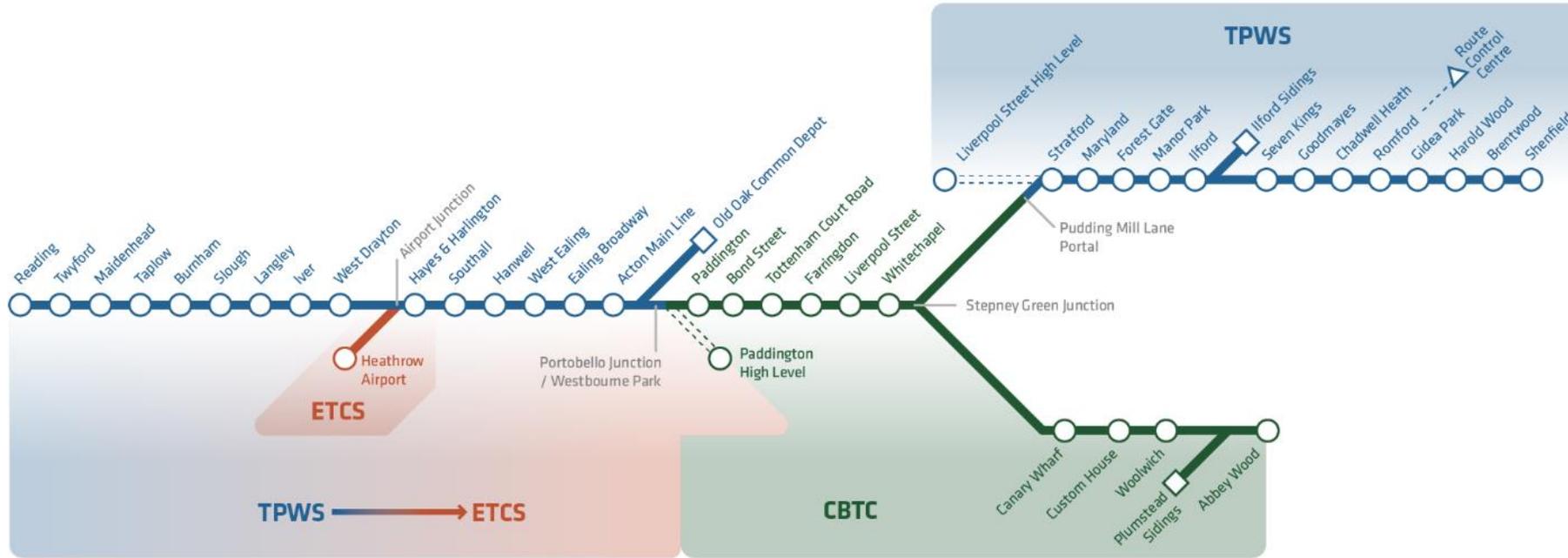
- 120kms
 - 21 kms twin bore tunnels
- 41 Stations
 - 10 new stations (8 underground)
- 24 trains per hour (30 tph specified)
- 70 new trains (200 mtrs)
- 3 Signaling Systems
- Platform Screen Doors

Original Project budget £15bn
Final spend £19bn

Original opening Dec 2018
Delay announced in August 2018

Opening 24 May 2022

Integrating Complexity - Three Signaling Systems



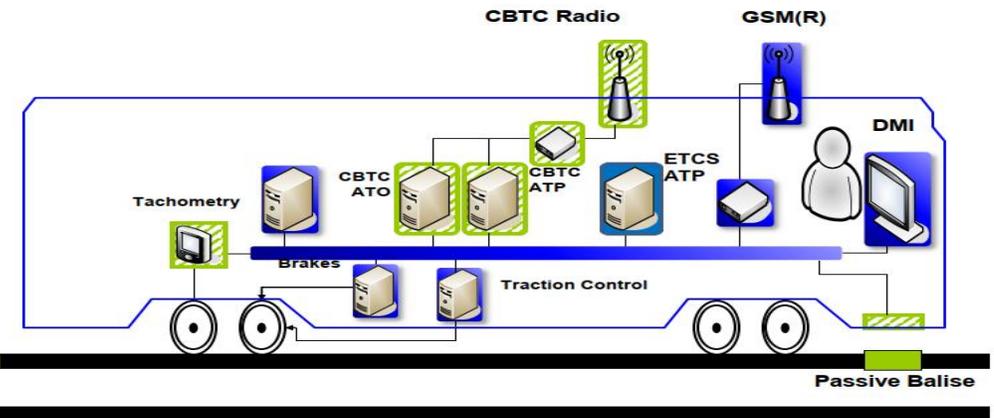
CBTC – Siemens TGMT3 (ATO, GoA3)

ETCS L2 – Alstom

TPWS – WABTECH

Rolling Stock - Alstom

- TCMS manages Single Driver Machine Interface



The Situation – January 2019

- Stage 1 Operation on Great Eastern commenced
- All Civils works complete
- Dynamic Testing had commenced

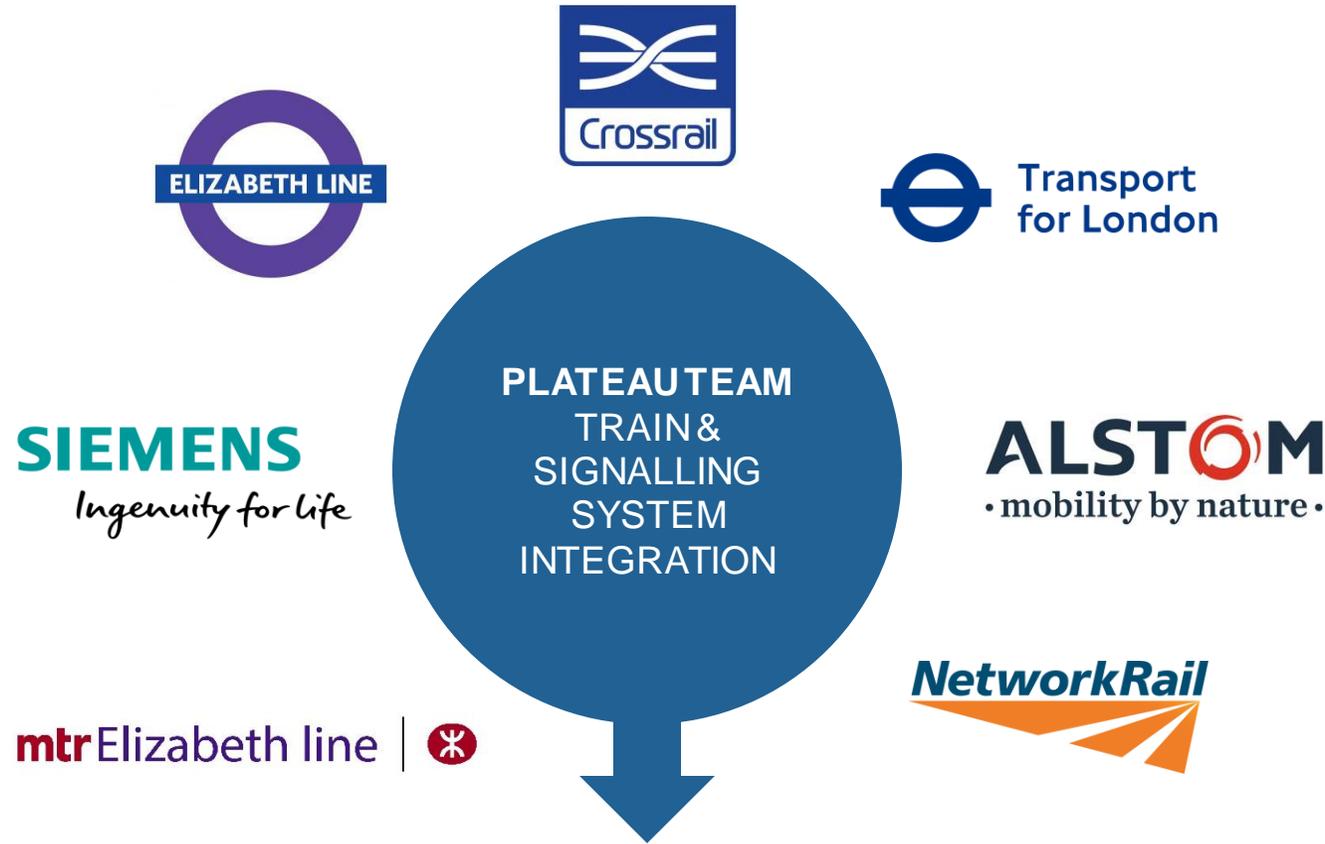
- Programme was managed as a portfolio of projects
- No System Integration ownership and limited Software management
- Significant routeway and stations fitout and commissioning work to be completed
- Handover and Assurance was based on completion (not partial)
- No strategy for staged delivery into service

- Immediate action was to establish a System Integration Department and Strategy
- Focus on the high risk and complex Rolling Stock and Signaling

The Challenges - Integration

- The complexity of 3 signaling systems and transition between them
- A single DMI across the 4 geographies and 3 signaling systems
- Technical and Operational Interfaces with PSDs/Tunnel Ventilation/SCADA
- Operational implications of partial functionality (and bugs) – Operational Restrictions
- The novelty of Metro style ATO and GoA3 Auto-reverse functionality
- ETCS L2 implementation as part of national scheme
- A number of railway functions across multiple contract boundaries
- The large number of stakeholders

Integrating Complexity – Collaborative ‘PLATEAU’



LEADERSHIP | COLLABORATION | TRUST
BEST PRACTICE | AGILE | FOCUSED

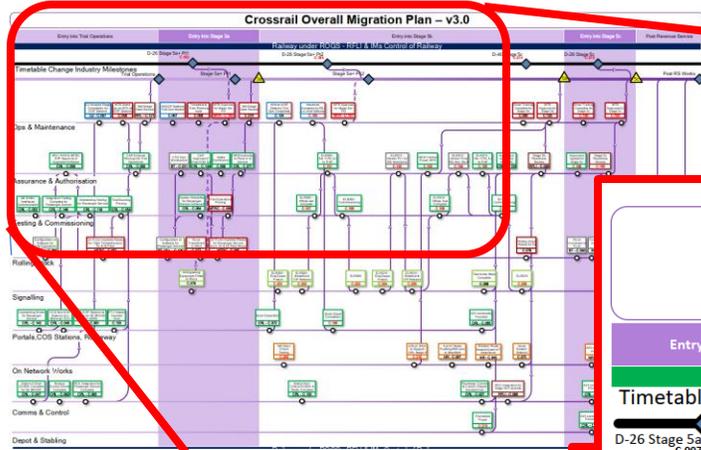
TECHNICAL & PROGRAMME INTEGRATION

MEMBERSHIP

- Crossrail Project team
 - Signaling
 - Rolling Stock
 - Testing & Commissioning
 - Assurance
- 4 Operators
 - Transport for London
 - MTR
 - Network Rail
 - Heathrow
- 2 Major Suppliers
 - Alstom
 - Siemens

Integrating Complexity – ‘Plateau’ Workstreams

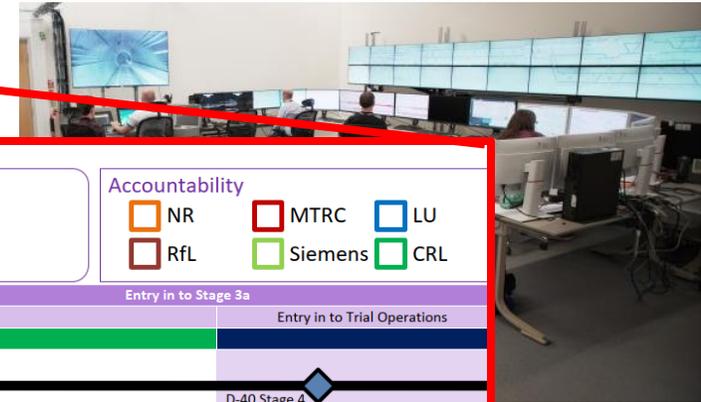
Migration Planning



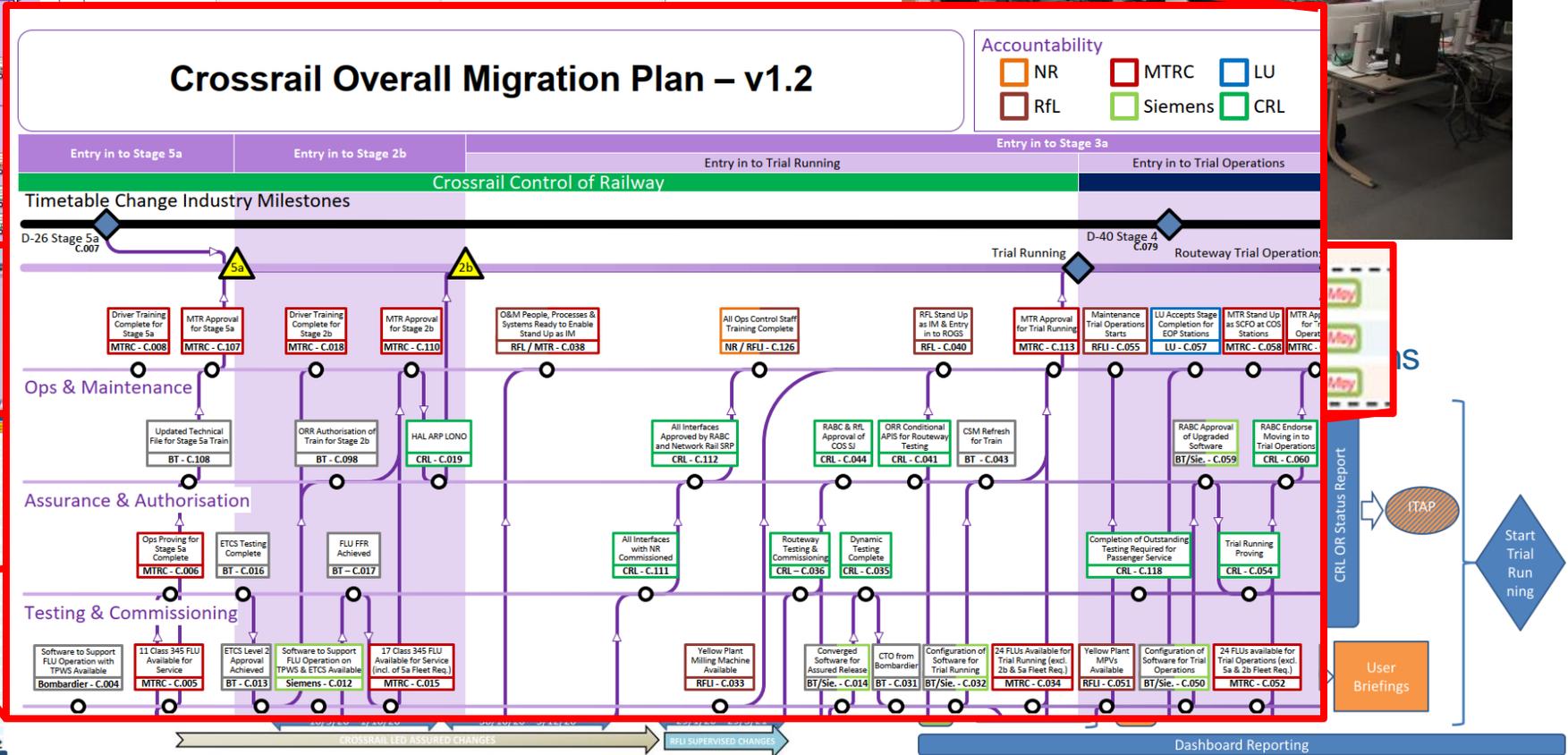
Minimum Functionality



Testing and Commissioning



Software Release Strategy

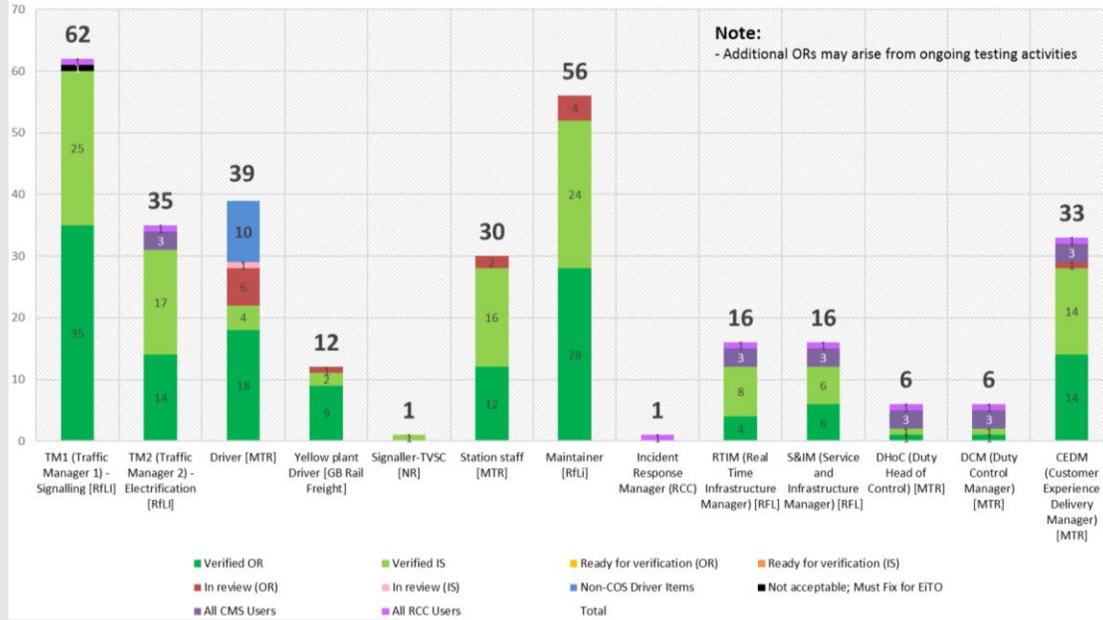


(Blue = CRL, Green = Suppliers + Planned Config, Orange = User Orgs)

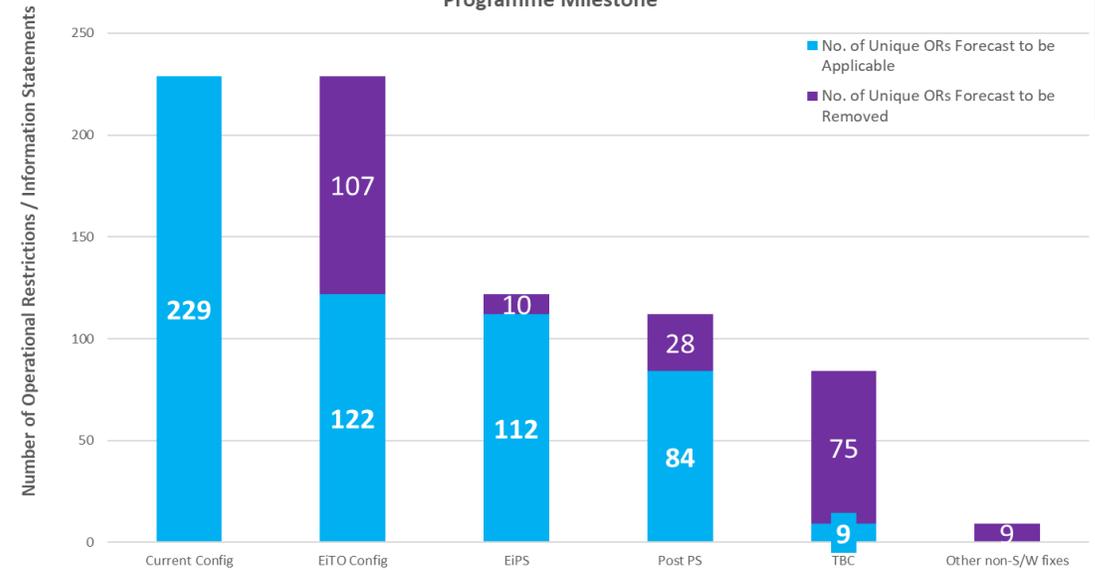


Plateau Workstreams - Operational Restrictions

OR Master Log - ORs/ISs by User Type - Current



Forecast Closure of Unique Operational Restrictions / Information Statements by Programme Milestone



Note that additional ORs will arise from ongoing testing and other programme activities

Achievements

- Successful handover of assets and mobilised Operators
- Worlds first integration of CBTC / ETCS L2
- UK's first interoperable introduction of ETCS L2
- UK's first Technical approval of Autoreverse on Mainline

- Successful opening of the railway as planned
- Service performing above 95% on-time (100% on most days)

Lessons Learned from Crossrail

- Own the whole - taking an Output based systems approach of the whole railway
 - The Client must own the problem and provide context of overall plan
- Transparency – trust and transparency to enable collaborative working
 - Joint management and commitment; vertically and horizontally integrated
- Coordinate Complexity – Integration is the key
 - Find focal points of progress to provide context for programme, operational and technical integration
- Simplify – don't try to manage everything
 - Identify what matters and focus on it, Staging will be the key to progress
- Everyone Crosses the Line Together
 - Involve all the players in the journey; jointly build the objectives, plans and drive to completion

