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ETCS & CBTC Interfaces – Crossrail Signalling

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MENA Conference, December 2015

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Network Rail and the British Railway System



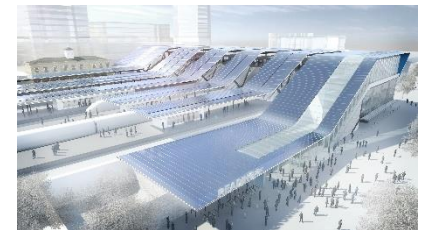
Key facts

The British Rail System

- ▶ £50 billion invested in our railway since 2002
- ▶ 29 billion tonne-kms of freight carried every year
- ▶ 1.6 billion passenger journeys every year
- ▶ 7 million train movements every year
- ▶ 31 operating companies use our infrastructure in the world's most liberalised railway

Network Rail

- ▶ £6 billion business
 - ▶ 35,000 dedicated employees
- We own, run, maintain and develop:
- ▶ 48,000 signals
 - ▶ 32,000 km of track
 - ▶ 30,000 bridges, tunnels and embankments
 - ▶ 2,500 stations leased to train operators
 - ▶ 19 major stations which handle 950 million passenger journeys



We are one of Europe's leading railways....



Source: European Commission Rail Study, March 2013



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Crossrail Signalling Challenges



End-to-End Traffic Management

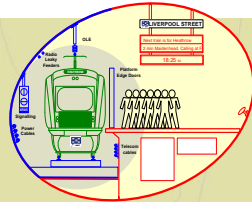
Crossrail 'outer'

- Signalling condition
- Interlocking alterability
- Control alterability
- AC immunisation
- Performance

Crossrail 'inner'

- Interlocking capacity
- Control centre capacity
- ATP to Heathrow
- Performance
- GW-ATP
- TSI

Central Section



CBTC Overlay / Interfaces

North Eastern Section

- Capacity (18tph)
- Performance (RAM)
- Compliance

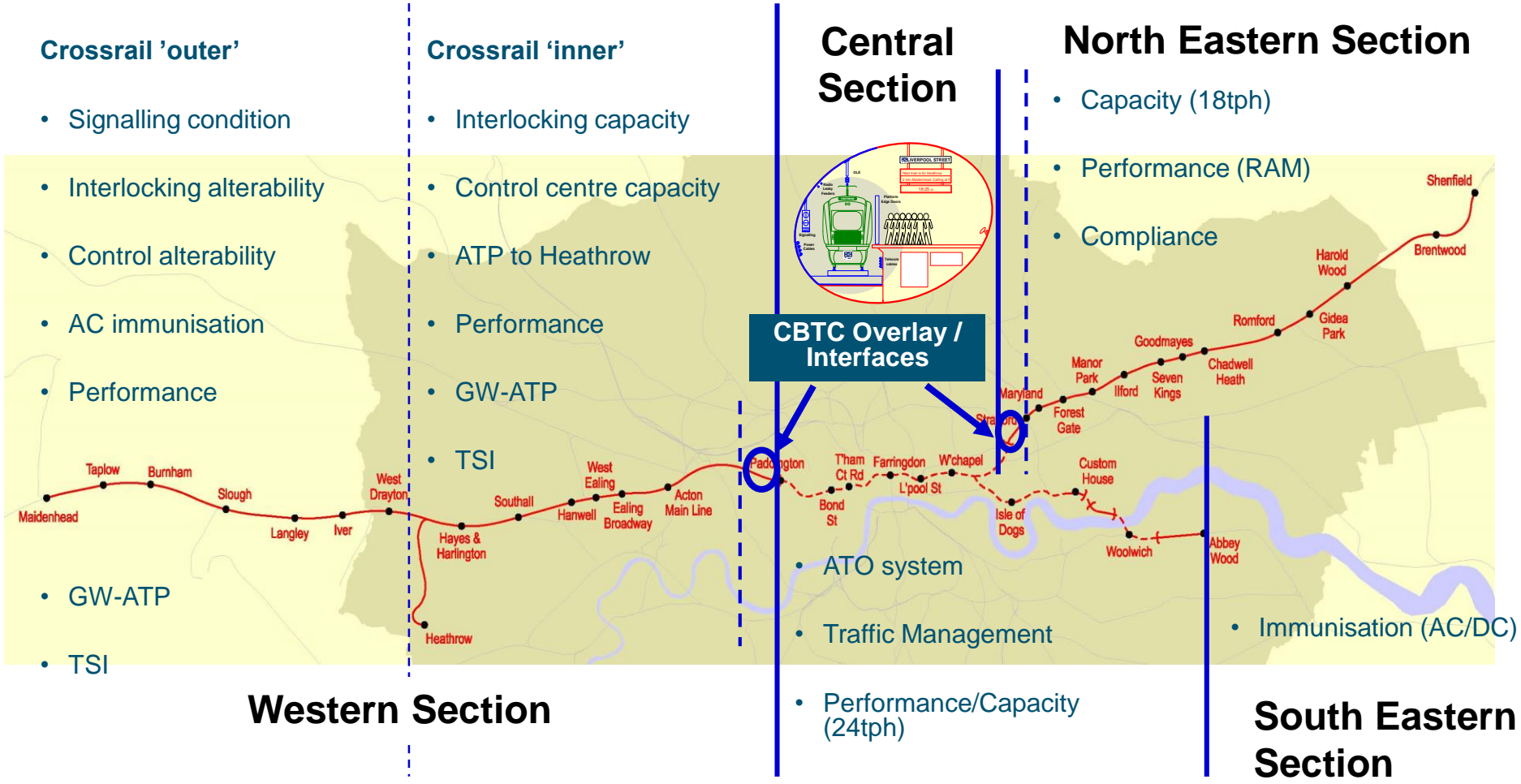
- GW-ATP
- TSI

Western Section

- ATO system
- Traffic Management
- Performance/Capacity (24tph)
- Interfaces

South Eastern Section

- Immunisation (AC/DC)



Deploy End-to-End Traffic Management / Regulation

- Conventional Resignalling
 - to immunise
 - to achieve RAM
 - to renew life expired assets
 - to enable enhancements

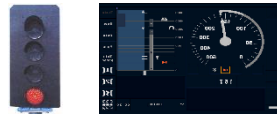
- Overlay ETCS L2
 - to meet the requirement not to fit GW-ATP on-board XR trains
 - TSI compliance
- Upgrade interlocking
- Transfer control to TVSC

- Line speed rationalisation
- Optimisations
- Derogations



- Transfer control to TVSC
- Overlay ETCS L2

- Deploy CBTC
- Deploy Traffic Management integrated with the ONW TM

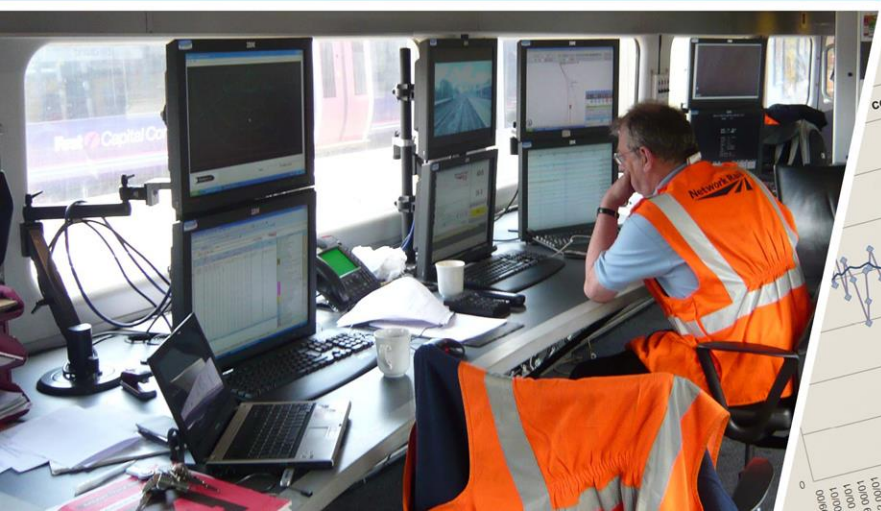


Summary of Challenges and Opportunities

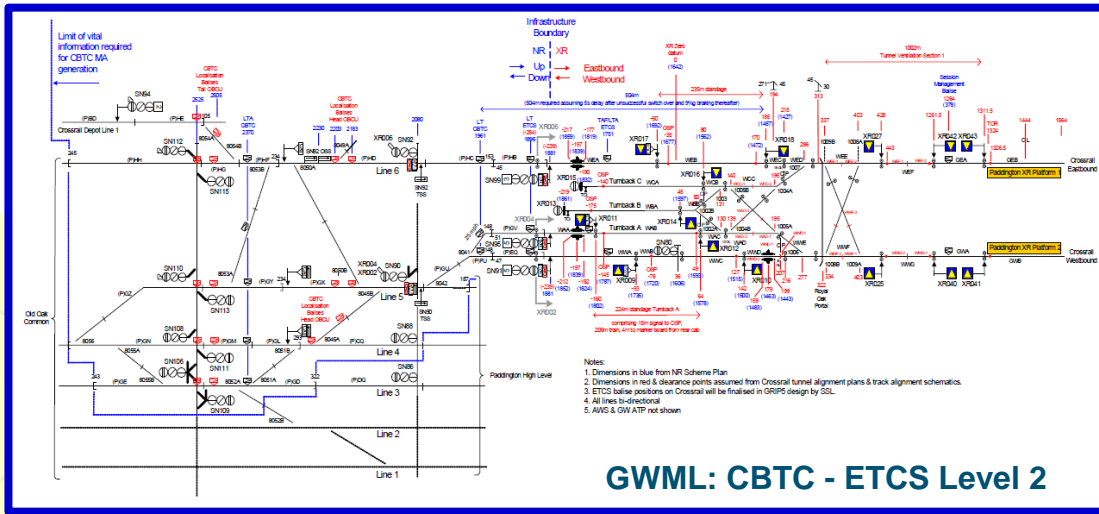
- Implementing the Enhancements for Crossrail
- Maximising the signalling contribution to Capacity (tph)
- Maximising the signalling contribution to Performance (PPM)
- Resignalling Slough RRI/PSB
- Upgrading the Western Inner Interlockings
- Recontrolling Western Section
- Deploying ETCS Level 2 (obsolete GW-ATP)
- De-risking the introduction of technology new to the UK
- Realising/optimising the benefits of cab-signalling
- **Interfacing ETCS and Conventional signalling with CBTC**

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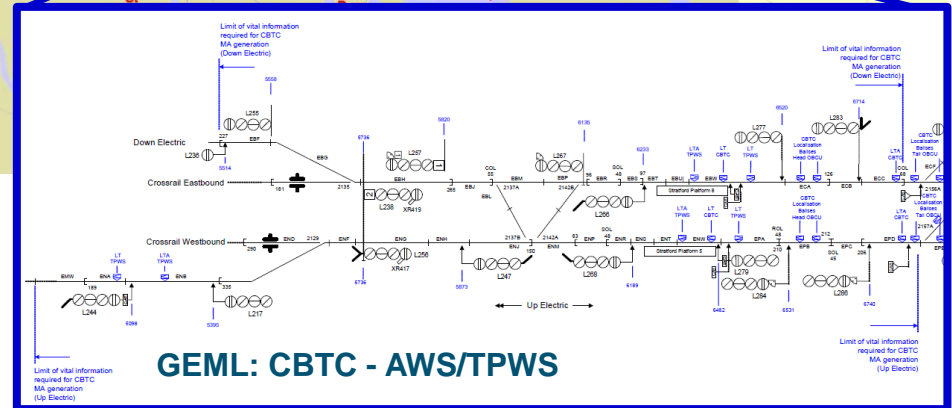
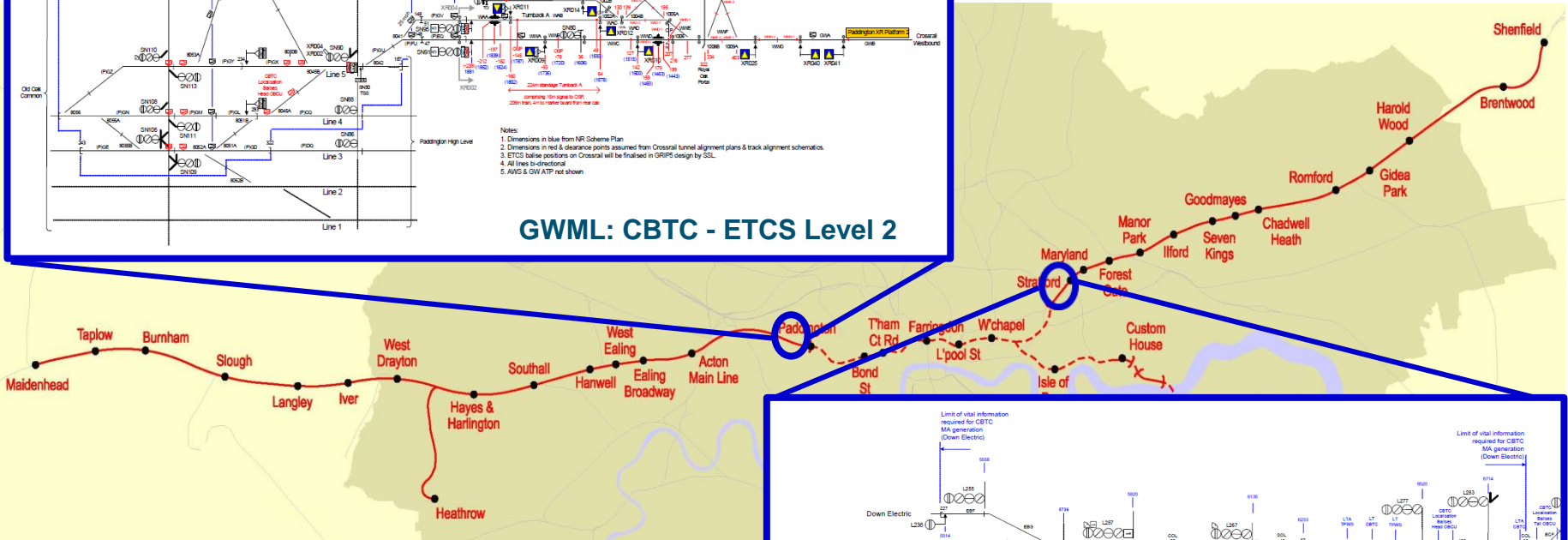
Interfacing CBTC with ETCS Level 2



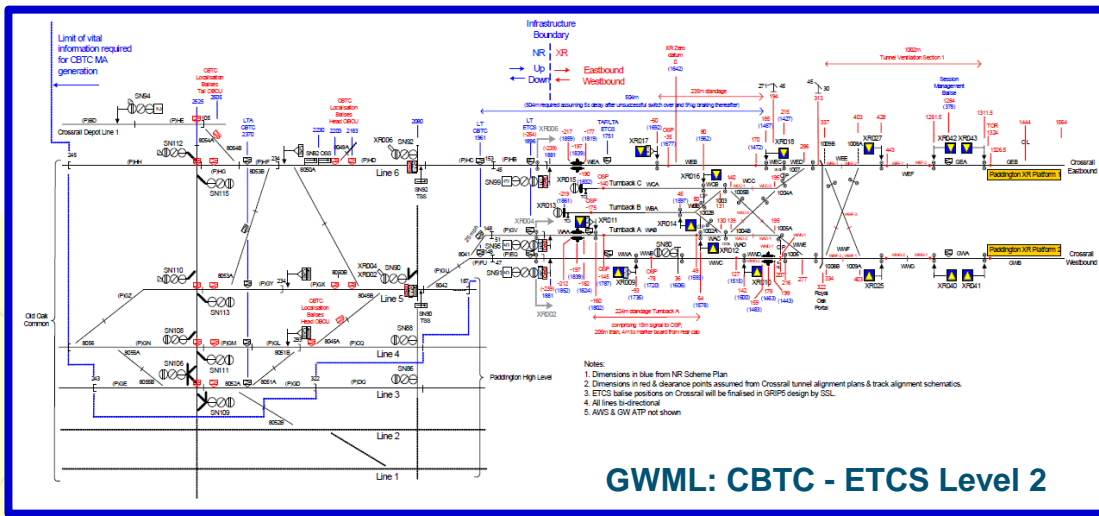
CBTC Interfaces



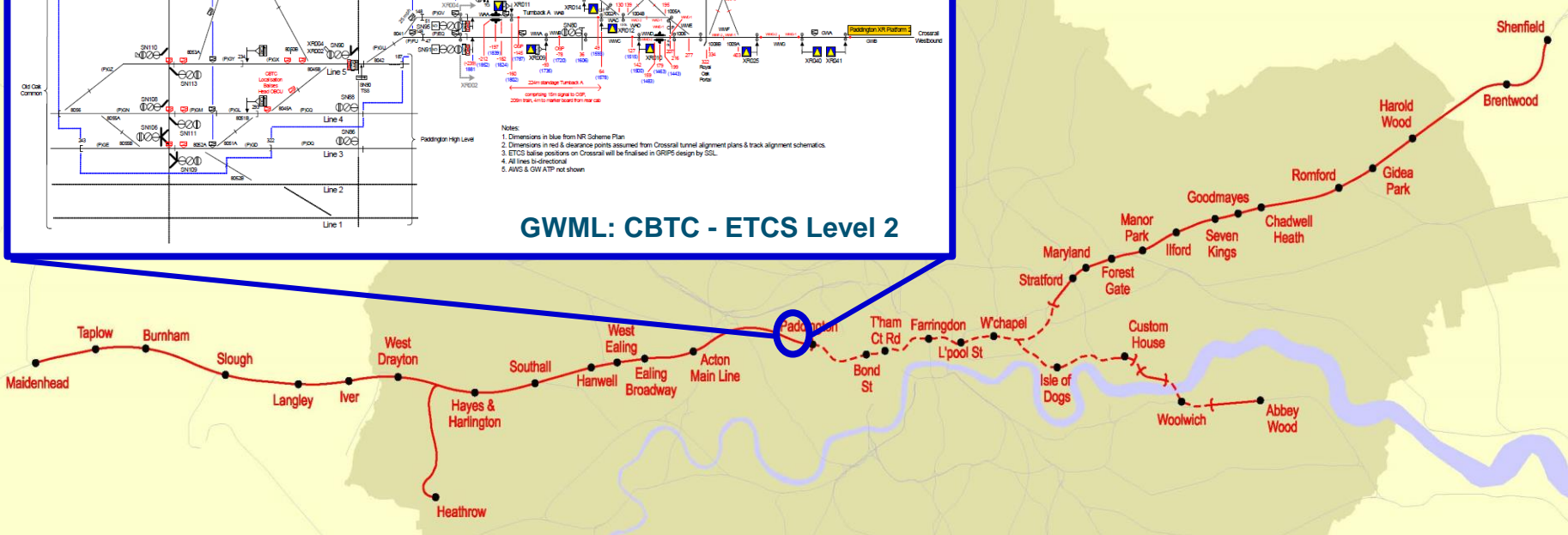
- Transition on the move, at any speed up line speed
- Only CBTC trains are allowed to enter the Central Section



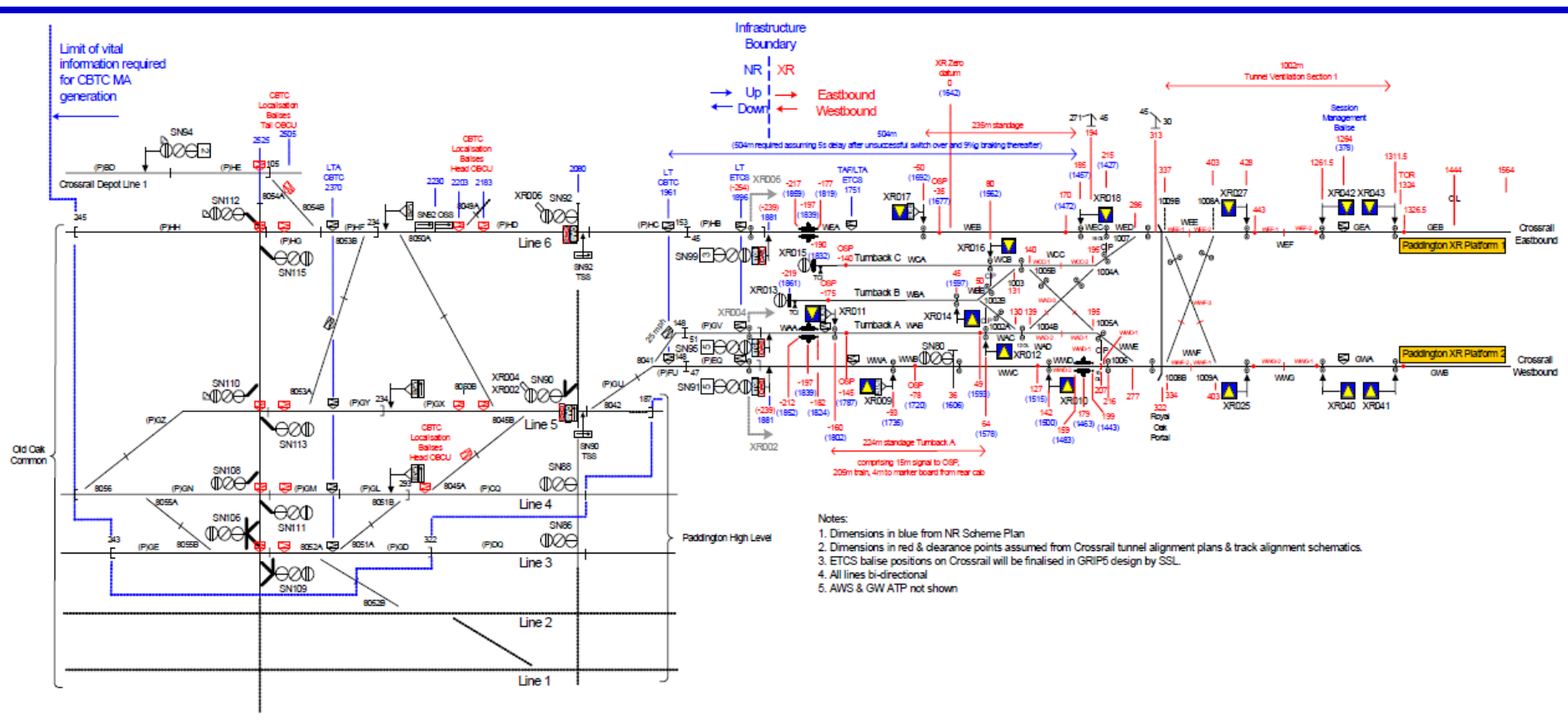
CBTC Interfaces



GWML: CBTC - ETCS Level 2

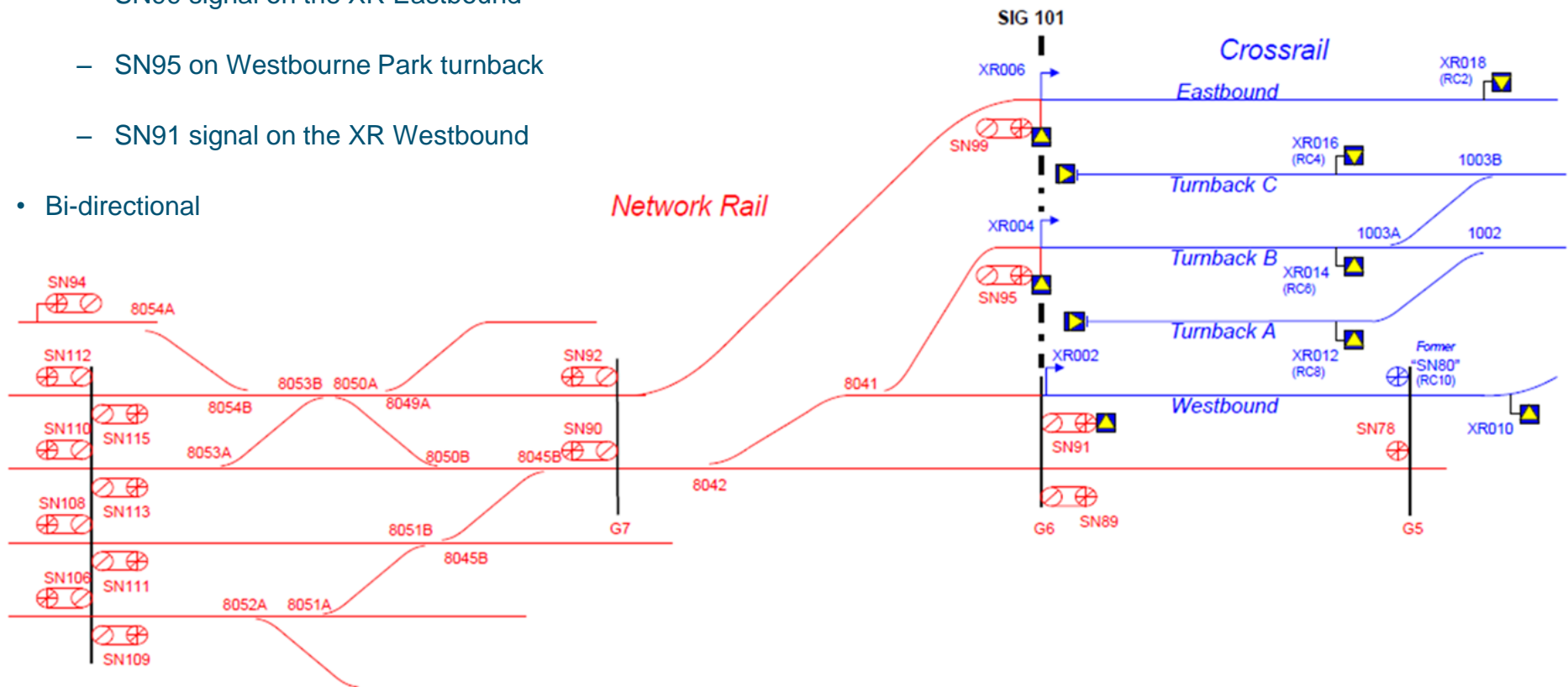


GWML: CBTC - ETCS Level 2



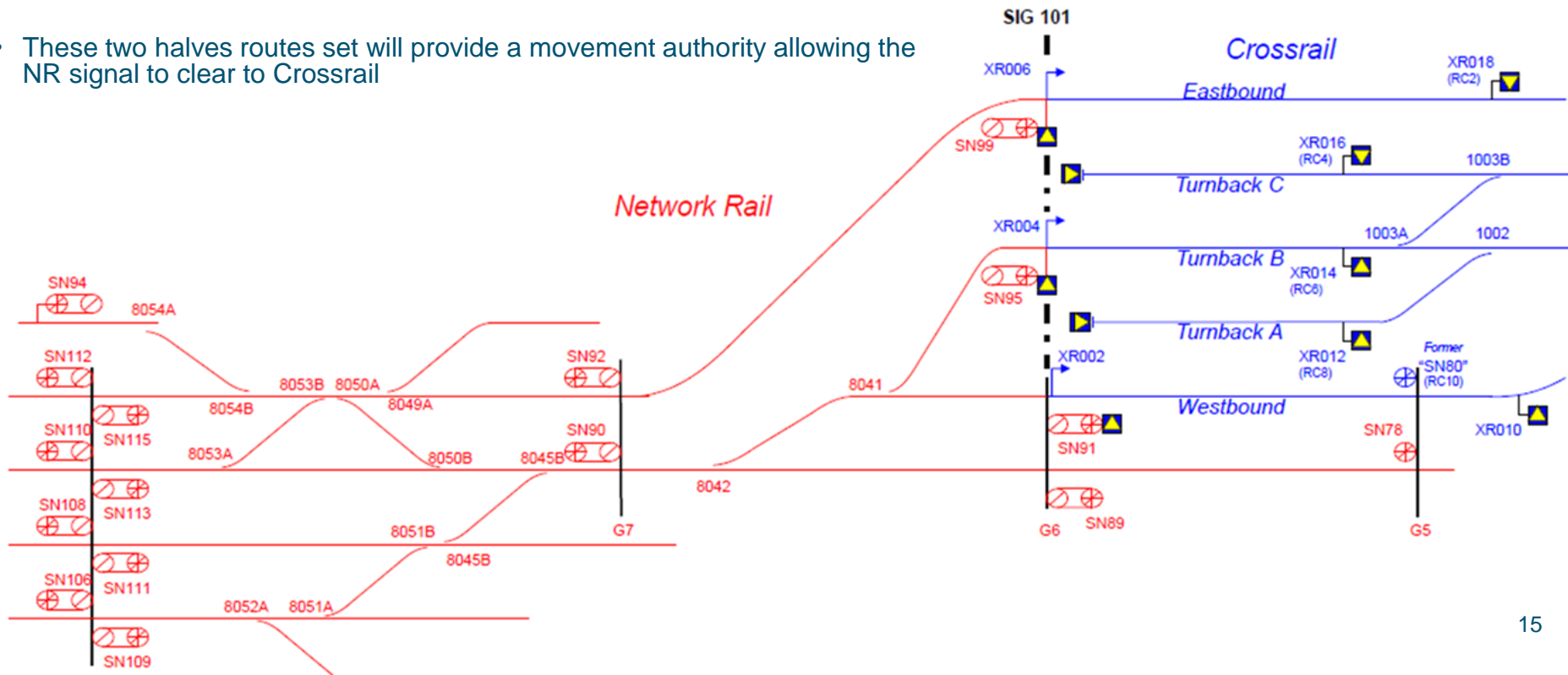
GWML : CBTC – ETCS L2 Interface

- Interlocking types denote the Infrastructure Control boundary. Smartlock 400 on NR territory (controlled from Didcot) and Westrace on Crossrail (controlled from Romford)
- The interlocking boundaries are:
 - SN99 signal on the XR Eastbound
 - SN95 on Westbourne Park turnback
 - SN91 signal on the XR Westbound
- Bi-directional



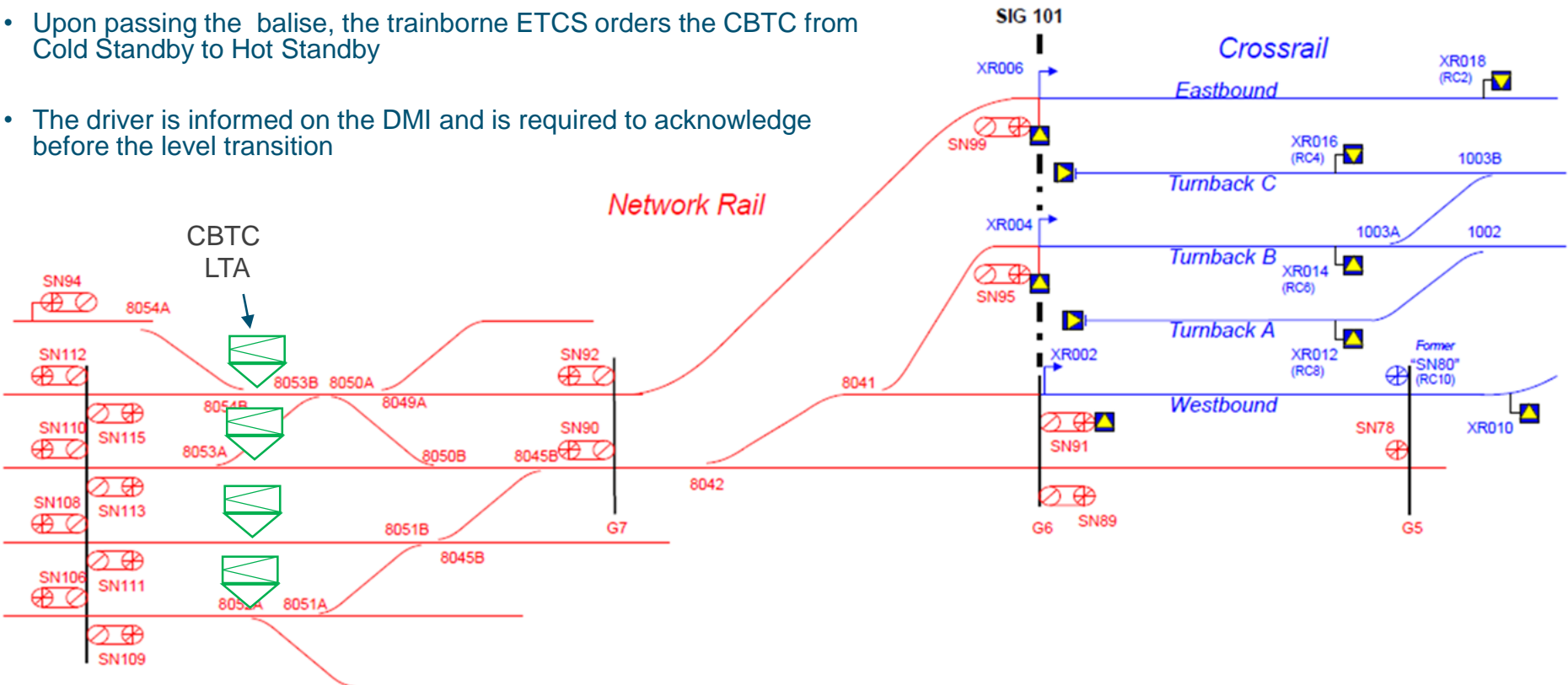
East Direction (Route Setting)

- Signals are installed at the demarcation between the two territories
- According to relevant TD and train approaching data, the NR ARS (or signaller) starts the route setting process to Crossrail by setting the “1st half route” (slot)
- The CRL ARS (or Signaller) sets the “2nd half route” towards the Crossrail lines (Eastbound or Turnback B or Westbound). This “2nd half route” also prevents any opposing moves being set from Crossrail
- These two halves routes set will provide a movement authority allowing the NR signal to clear to Crossrail



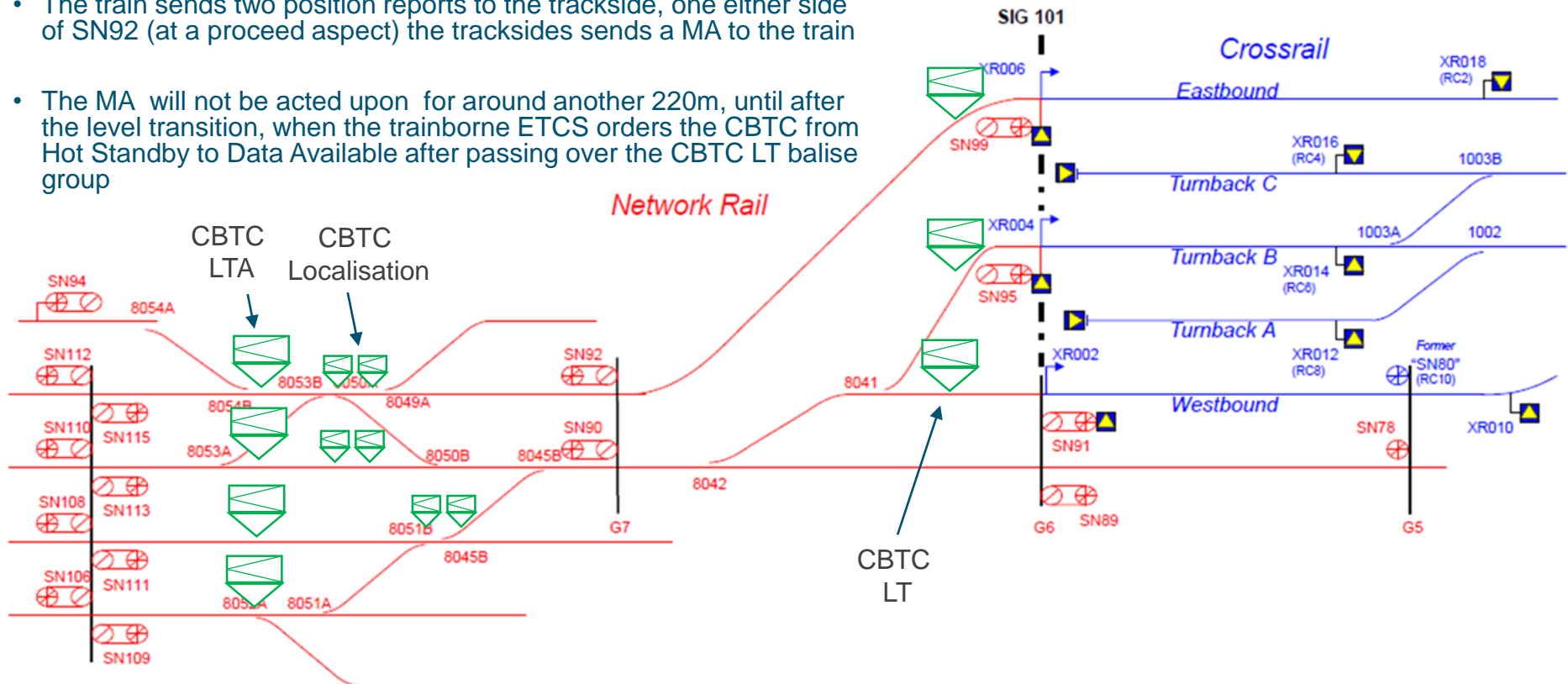
East Direction - Transitions

- Transition shall be in accordance with Subset-035 issue 3.0.0, ERTMS/ETCS Specific Transmission Module (FFFIS)
- In normal operation, Crossrail trains approaching SN92 will be driven in FS mode with ETCS L2 protection, receiving movement authorities from the ETCS RBC
- Level transition announcement is provided at a CBTC announcement balise group
- Upon passing the balise, the trainborne ETCS orders the CBTC from Cold Standby to Hot Standby
- The driver is informed on the DMI and is required to acknowledge before the level transition



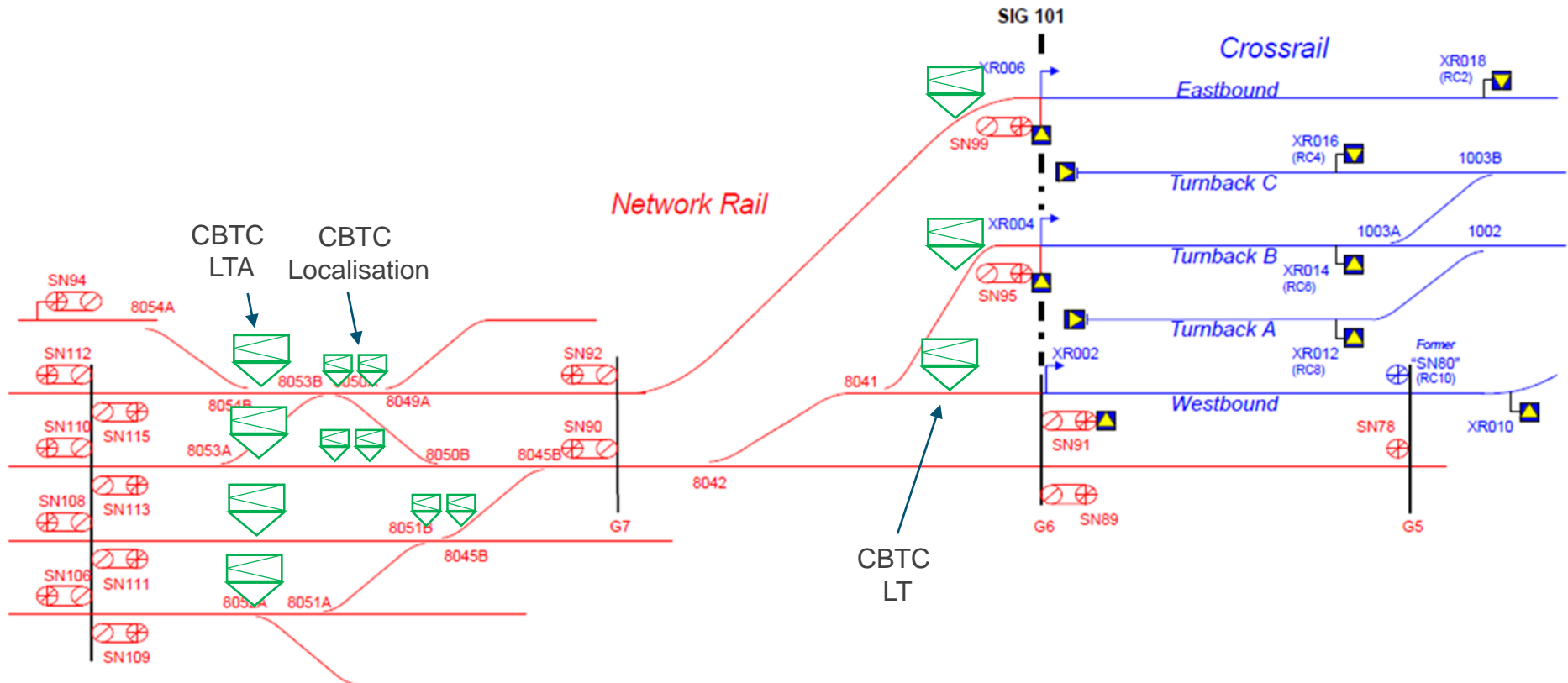
East Direction - Transitions

- SN112 will not display a proceed aspect unless the route from SN92 or SN90 has been set
- When the CBTC is active, the train will start to be located for CBTC at the 1st localisation balise
- The train sends a position reports to the trackside CBTC when located at the 2nd localisation balise (around 20m after the first)
- The train sends two position reports to the trackside, one either side of SN92 (at a proceed aspect) the trackside sends a MA to the train
- The MA will not be acted upon for around another 220m, until after the level transition, when the trainborne ETCS orders the CBTC from Hot Standby to Data Available after passing over the CBTC LT balise group



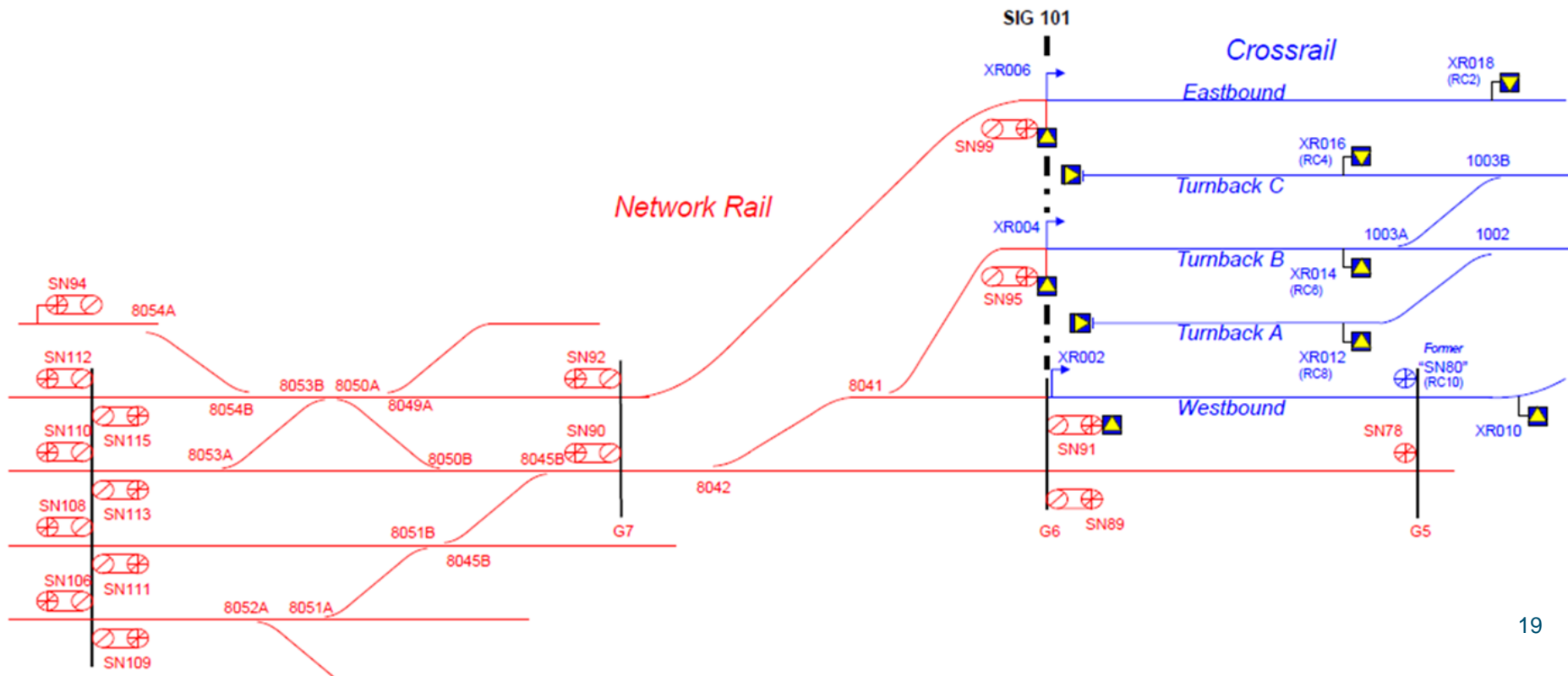
East Direction - Transitions

- Successful level transition to CBTC will result in the train being driven in Protected Manual mode to the target speed displayed on the DMI and protected by the vital movement authority
- The driver will then be prompted by a DMI announcement to manually switch from Protected Manual to Automatic Mode
- Procedures are in place if the train fails to make the transition



West Direction (Route Setting)

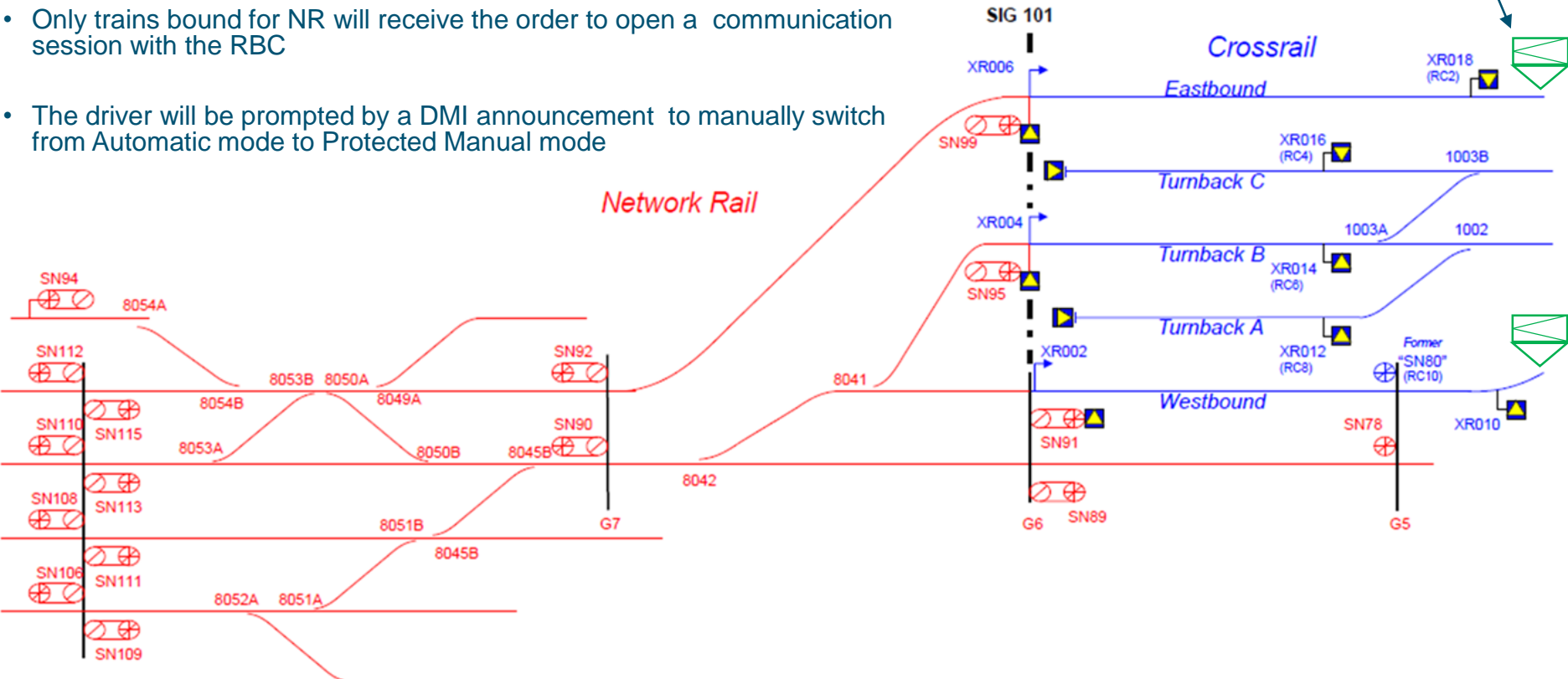
- Signals are installed at the demarcation between the two territories
- According to relevant TD and train approaching data, the NR ARS (or signaller) sets the route to NR
- Functions are exchanged across the boundary to suit the NR interlocking arrangements and movement authority transmitted to Crossrail signalling and control system



West Direction - Transitions

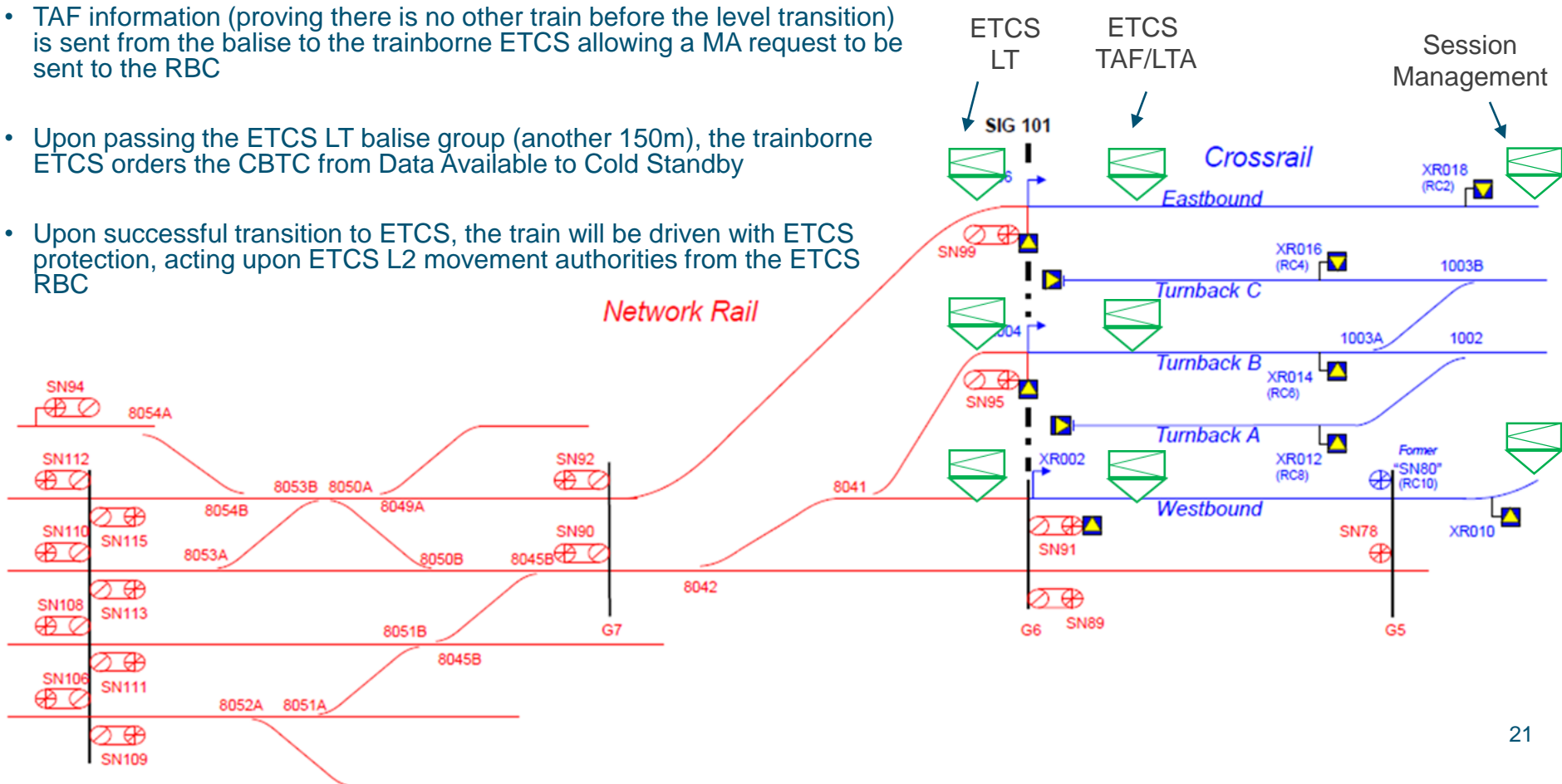
- Transition shall be in accordance with Subset-035 issue 3.0.0, ERTMS/ETCS Specific Transmission Module (FFFIS)
- In normal operation, Crossrail trains leaving Paddington XR station bound for NR will be driven in Automatic mode with CBTC protection, receiving movement authorities from the CBTC trackside system
- The train passes over the session management balise
- Only trains bound for NR will receive the order to open a communication session with the RBC
- The driver will be prompted by a DMI announcement to manually switch from Automatic mode to Protected Manual mode

Session Management



West Direction - Transitions

- Level transition announcement occurs at the TAF/LTA ETCS switchable balise group
- The driver is informed on the DMI and is required to acknowledge before the level transition
- TAF information (proving there is no other train before the level transition) is sent from the balise to the trainborne ETCS allowing a MA request to be sent to the RBC
- Upon passing the ETCS LT balise group (another 150m), the trainborne ETCS orders the CBTC from Data Available to Cold Standby
- Upon successful transition to ETCS, the train will be driven with ETCS protection, acting upon ETCS L2 movement authorities from the ETCS RBC



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Conclusions



Conclusions

ETCS and CBTC deployments can co-exist, providing a solution for integrating mainline services with a high frequency metro style section

Likely to be longer-term convergence of ETCS and CBTC technologies to provide an interoperable solution - Thameslink Programme are already implementing ATO over ETCS



Network Rail Consulting is here to help develop a strong railway capability in the Middle East by drawing upon decades of learning and experience in the UK

Thank you

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