Challenging established rules for train control through a fault tolerance approach: application at a Classic Junction

Ronghui Liu, Anthony Whiteing & Andrew Koh
Institute for Transport Studies
University of Leeds

In partnership with
Prof TX Mei, Samia Nefti-Meziani & Zia Ursani
University of Salford
Background

• An EPSRC/RSSB-funded project on improving rail network capacity
• The Current rail operating rules “Current Rule”:
  – The blocking principle: railway operation is safety-critical (err on side of caution).
  – But comes at a COST ➔ reduce capacity of tracks because trains keep a two block separation
• Fault tolerant approach to the operation (and design) of the rail network
  – focused on strategies to “relax” rules of railway signalling to increase capacity without compromising safety focusing on making best use of capacity through “Fault Tolerance” (FT) concept
  – FT: design a system to live with faults (a concept from other disciplines)
  – Seek small changes at junctions over a network which can have large cumulative gains
An example: a ‘Classic’ junction

• Train A2 is scheduled to turn right at the junction
• Train B is coming the opposite direction across the junction, but is expected to have cleared the section before train A2 reaches the points

• Rule change: allow train A2 to approach at a higher speed than if expecting to stop ➔ modification to speed profile
“Relaxing the rules”

- **Current rule**: A2 slows down towards YELLOW
- **Moderate FT**: Full speed up to YELLOW
- **Ultimate FT**: Full speed up to the RED, divert if junction is not cleared
The model is adapted from an existing road network model developed at University of Leeds, allowing:

- perturbation in trains’ arrival/departure times, and perturbation in trains’ journey times, to be modelled; and
- different operating rules to be tested in a simulated environment.
Space-time trajectories of trains

- Under current rule, any earlier arriving A2 train experiences delay (∵ slowing down on sighting yellow)
- Shown by dashed lines in figures
- Potential saving in time and headway with FT rules
Summary

- Application of FT rule to a simple but relatively common classic junction scenario shows potential advantages

→ Able to schedule A2 trains (*by up to 72 secs under Ultimate FT*) earlier so can run more A2 trains over a particular time period without compromising safety

→ Can schedule more B trains as well in the following pattern (A2-B-A2) since the spacing is reduced by up to 2 block lengths

**Further work**: consider multiple platforms at stations, multiple tracks at junctions where scope for FT exists