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Digital Signalling And Traffic Management As A Capacity Lever For Uzbekistan's Railways: Lessons From European Practice

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Abstract

This thesis argues that digital signalling and traffic management are the cheapest available source of new capacity for Uzbekistan's railways, whose freight and transit volumes are growing faster than track can be built. European evidence attributes 15–35% additional capacity to the combination of digital interlocking, ETCS Level 2 and automated traffic management. Uzbekistan already operates computer-based interlocking on several southern lines and began digitising dispatching in 2026 with EBRD support; the missing steps are network-wide traffic management, a modern train-protection layer and a 5G-ready radio strategy. A four-stage migration path is proposed.

Keywords: *digital signalling, ERTMS/ETCS, computer-based interlocking, traffic management system, FRMCS, railway capacity, Uzbekistan.*

1. Introduction

Uzbekistan's railway demand is outpacing its physical network. In 2025 the railways carried 106.4 million tonnes of freight and transit exceeded 12 million tonnes [1]. Construction is accelerating — 151 km of new lines, 182 km of electrification and the modernisation of 27 stations are planned [2] — but new track takes years. Capacity on the existing 6,950 km network [3] is therefore the binding constraint for the next decade.

2. Methodology

Signalling determines how closely trains can follow each other and how quickly a disrupted timetable recovers. On a legacy fixed-block system, headway is set by block-section length and by the reaction time of human dispatchers; digital signalling shortens both. This thesis asks which elements of the digital signalling stack Uzbekistan should prioritise, given what it already has and what international practice shows.

3. Result and discussion.

Global evidence. The largest capacity gains come from layering technologies, and the traffic management layer contributes as much as train protection. A 2024 study for Digitale Schiene Deutschland found that the roughly 15% capacity gain depends on combining digital interlocking and ETCS Level 2 with automated dispatching and automatic train operation [4]. The German federal government's agreement with Deutsche Bahn puts the long-run potential of ETCS plus digital interlocking at up to 35% [5]. Table 1 summarises the stack.

Table 1.
Layers of the digital signalling stack and international evidence

Layer	Function	International status	Reported effect
Digital interlocking	Software-based route setting	DB plans network-wide replacement of legacy interlockings	Prerequisite for ETCS
ETCS Level 2	Continuous in-cab speed supervision	12,400 km (10% of TEN-T) equipped in the EU by end-2024; 19% of fleet fitted; Belgium 100% in 2025	Part of the 15–35% range
Traffic management (TMS)	Automated timetable and conflict resolution	Trialled together with ETCS in Germany	Needed to realise ETCS gains
Radio (GSM-R → FRMCS)	Data link for ETCS and voice	GSM-R on ~130,000 km; switchover to 5G FRMCS targeted around 2030	Enables data-heavy applications

European experience also carries two cautions: deployment is slow when trackside and on-board equipment are not procured together [6], and the FRMCS specification itself is running late, which places it on the critical path for replacing GSM-R [7].

Uzbekistan's position. Uzbekistan started digital signalling early, but progress is concentrated on a few lines. In 2007 Uzbekistan Railways contracted computer-based interlocking for the 223 km Tashguzar–Kumkurgan line, equipping 17 stations with EBIlock 950, axle counters, LED signals and centralised traffic control; later projects in 2014–2019 extended it to 14 more stations [8]. The weak link is the layer above interlocking: the EBRD's 2026 loan of up to €38.4 million exists precisely because dispatching, scheduling and operational control still rely on manual processes [9]. Figure 1 places Uzbekistan on a four-stage path with explicit gates.



Figure 1. Proposed signalling migration path for Uzbekistan

The gates matter more than the stages: train protection installed before a unified data model and digital dispatching would reproduce the European problem of equipment that is fitted but under-used [10].

4. Conclusion

Uzbekistan should treat traffic management, not train protection, as its next signalling investment. Three recommendations follow: extend digital dispatching beyond the EBRD project scope to all transit corridors, with open interfaces; specify every new line and re-signalling contract as "ETCS-ready"; and plan the radio layer directly for 5G-based FRMCS rather than investing further in GSM-R. Capacity estimates come from European mixed-traffic networks, so their transfer to Uzbekistan's freight-dominated sections should be verified by simulation on national timetable data.

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