



FROM NODE TO NETWORK: HOW TRANSPORT INTERCHANGES DEFINE THE PATHWAYS TO RAILWAY TRANSFORMATION

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Abstract – Railways are increasingly expected to serve as the structural backbone of decarbonised, urbanised and digitally integrated mobility systems. This work argues that the pathway to railway transformation runs through transport interchanges, and that a railway's value is created less at the node than through it. Drawing on network science, we reconceptualise the interchange as a physical, modal, informational and urban junction whose quality is a network variable: transfer friction at a single node propagates into the effective connectivity, resilience and reach of every route passing through it. We propose a six-tier typology of interchanges, from local halts to high-speed international hubs and freight–passenger co-located nodes, with a five-dimension assessment framework covering connectivity, transfer friction, resilience contribution, land-use integration and passenger experience. Comparative evidence from European case studies shows that, despite divergent primary levers, successful schemes share a common narrative: multi-actor governance, friction reduction by design and network-level demand effects. The digital layer, comprising Mobility-as-a-Service, real-time information, station digital twins and fare interoperability, can deliver connectivity gains comparable to civil works at lower cost. Situating the analysis within the 2026 European policy context, including TEN-T requirements for multimodal passenger hubs in 431 urban nodes by 2030 and proposed single-ticket passenger rights contingent on minimum connection times, we present an iterative Diagnose–Design–Integrate–Govern–Evaluate pathway model. We conclude that railway transformation is as much an institutional challenge as an engineering one, demanding appraisal, funding and governance at network scale.

Keywords - transport interchanges; multimodal hubs, railway governance, TEN-T urban nodes, network centrality.

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