SIDE-BY-SIDE COMPARISON

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CBTC vs Conventional Signaling

Eight axes on which moving-block CBTC and fixed-block signaling actually diverge — with the US deployment numbers that make the business case.

AXIS	CONVENTIONAL FIXED BLOCK	CBTC
Separation logic	Fixed sections. One train per block; the follower waits until the block is fully cleared.	Computed buffers. A Movement Authority ends a safe distance behind the train ahead, resized continuously.
Train detection	Track circuit. The wayside infers occupancy from shorted rails and never knows where in the block.	Onboard report. The train fixes its own position by sensor fusion and transmits it dozens of times a minute.
Capacity ceiling	24–28 trains/hour/direction in practice, set by block length, dwell variability and operator reaction.	30+ trains/hour/direction. A well-designed line lifts the ceiling 20–40 percent.
Safety model	Discrete signal compliance. Safety rests on the operator reading and obeying an aspect; failures are logged as SPADs.	Continuous supervision. ATP compares speed against the permitted curve every cycle and brakes without consulting the driver.
Wayside infrastructure	Dense. A 50 km line typically carries 150–200 signal heads, as many track circuits, and 4–6 relay houses.	Consolidated. One zone controller per 2–5 km, radio access points every 250–500 m, balises roughly every 200 m.
Capital & lifecycle cost	Front-loaded. $8–15M per 10 km of track for a US resignaling; long-lived electromechanical assets.	Distributed. $15–25M per 10 km before fleet equipment; software and radio refresh cycles recur.
Degraded-mode behavior	Blunt. Loss of detection or signaling drops the affected territory to restricted manual working.	Graduated. Defined fallbacks step down through reduced-performance modes before reaching manual.
Vendor & supply chain	Many. A deep, fragmented base with real second-sourcing and decades of installed-base spares.	Few. Roughly five suppliers worldwide; the platform choice is a multi-decade commitment.

The first row causes the other seven. Once separation stops being a property of the infrastructure and becomes a computation over live train state, detection has to move onboard, the capacity ceiling stops being set by block length, enforcement stops depending on a human reading an aspect, and most of the wayside stops being necessary. Read the sheet top-down and the argument assembles itself.

What the conversions actually delivered

LINE	BEFORE	AFTER	NOTE
Paris Métro Line 1	~20 tph	27 tph	Siemens conversion of an operating line, carried out under traffic.
Hong Kong Tsuen Wan	18 tph	24 tph	A third more throughput on unchanged civil infrastructure.
NYCT L Line	~20 tph	24–29 tph	The US flagship retrofit; no civil works. Roughly $48M per km on a complex line.

Where the argument is usually lost. Not on capacity, which is easy to evidence, but on the last row. A fixed-block estate can be maintained from a deep parts market for fifty years. A CBTC line ties the agency to one of about five suppliers for the life of the asset, which is why interface specifications, data rights and spares terms belong in the RFP rather than in the first change order.

Adapted from *Communications-Based Train Control*, Volume 1, Chapter 1, by Chunjun (Francisco) Wang, and the companion article on the eight differences. Capacity figures are for peak trains per hour per direction on the named lines; cost ranges are US brownfield practice and exclude fleet equipment unless stated.