

CBTC Acronyms & Glossary

The vocabulary a CBTC specification, bid or design review takes for granted — grouped the way the words actually appear in the work rather than alphabetically.

CBTC · Communications-Based Train Control. Per IEEE 1474.1: continuous automatic train control using high-resolution train location determination independent of track circuits, continuous bidirectional train-to-wayside data communications, and onboard and wayside processors implementing vital functions.

ATC · Automatic Train Control. The umbrella for the three layers: ATC = ATP + ATO + ATS.

ATP · Automatic Train Protection. The safety-critical layer that supervises movement against the current Movement Authority and brakes if the train would exceed it. SIL 4, mandatory at every GoA, not overridable by the driver.

ATO · Automatic Train Operation. The driving-automation layer that commands traction and braking inside the ATP envelope: station-stopping accuracy, energy-optimized cruising, door enable.

ATS · Automatic Train Supervision. The control-room layer: timetable execution, dispatching, regulation, route setting and operator displays. Advisory, and non-safety-critical.

ZC · Zone Controller. The wayside computer owning one geographic zone (typically 2–5 km), tracking every train in it, issuing Movement Authorities and handing off to neighboring zones.

VOBC · Vehicle On-Board Controller. The train-resident vital computer running ATP supervision, ATO commands, balise reading, odometry fusion and DCS communication.

OBCU · Onboard Controller Unit. A supplier-dependent synonym for VOBC; VOBC is the preferred term in US practice.

DCS · Data Communication System. The wireless network carrying train-to-wayside data — commonly 2.4 or 5 GHz spread-spectrum radio, increasingly LTE-R or private 5G.

CI · Computer-based Interlocking. The processor-based successor to relay interlocking, setting and locking routes and owning switches and signals.

EI · Electronic Interlocking. Used interchangeably with CI in most US specifications.

TIU · Train Interface Unit. The onboard gateway between the VOBC and the train's traction, braking and door systems.

Wayside · Everything track-side: zone controllers, interlocking, radio access points, balises and their housings.

Onboard · Everything train-side: VOBC, antennas, odometry sensors, balise reader and the train interface.

Carborne · A synonym for onboard, common in older US specifications and some vendor documentation.

Central · The control-centre tier: ATS servers, operator workstations, playback and performance tooling.

OCC · Operations Control Centre. The physical room and organization from which the railway is dispatched and supervised.

ATS workstation · The dispatcher's console: line overview, alarms, manual intervention and route requests.

Wayside ATP · The portion of the protection function computed track-side,

principally in the zone controller, as distinct from onboard ATP.

Trackside object controller · A distributed unit that drives points, signals or other field elements on behalf of the interlocking, reducing cable runs.

MA · Movement Authority. The wayside's signed permission to a single train to proceed to a defined point at a defined speed. Refreshed every 200–500 ms in modern deployments.

EoA · End of Authority. The point at which a Movement Authority terminates; ATP enforces a braking curve that stops the train short of it under worst-case assumptions.

LoA · Limit of Authority. Used interchangeably with EoA by several suppliers.

SvL · Supervised Location. The protected point beyond the EoA that the safe braking calculation actually targets, providing the overlap margin.

Moving block · CBTC's defining concept: a continuously recomputed separation buffer sized to speed, braking performance and the position of the train ahead.

Fixed block · Traditional separation: the track is divided into sections, each occupied by at most one train. Capacity is bounded by block length.

Virtual block · A software-defined block used where full moving block is not implemented; separation is finer-grained than physical track circuits but still quantized.

Block (CBTC context) · A short virtual segment, typically 100–200 m, used for position reference and balise placement — not the unit of separation.

Headway · The time between successive trains at a fixed point. The primary CBTC capacity metric.

TPHPD · Trains Per Hour Per Direction. The throughput equivalent of headway, and the number most business cases are actually judged on.

Design headway · The headway the system is engineered to sustain, as distinct from the timetabled headway actually operated.

Dwell · The time a train spends stopped at a platform. Above roughly 100-second headways, dwell variability rather than signaling usually sets the ceiling.

Braking curve · The deceleration profile ATP enforces from current speed to the EoA, accounting for grade, brake fall-off, traction cutoff and worst-case reaction time.

Safe braking distance · The worst-case distance from current speed to a full stop. Drives the size of the moving-block buffer.

Guaranteed emergency brake rate · The deceleration the train is contractually assumed to achieve under worst-case conditions; the safety case is built on it, not on typical performance.

Service brake · Normal deceleration commanded by ATO or the driver, inside the ATP envelope.

Emergency brake · Maximum deceleration commanded by ATP when the envelope would otherwise be exceeded. Not modulated.

Overspeed · Any state in which actual speed exceeds the permitted curve; the trigger for ATP intervention.

Civil speed limit · The permanent speed restriction imposed by track geometry and structures, enforced by ATP independent of any temporary restriction.

TSR · Temporary Speed Restriction. A time-limited limit applied for works or defects, distributed through ATS and enforced by ATP.

Coasting · Running without traction to save energy; a standard ATO optimization

where the timetable allows the run time.

Regulation · The ATS function that adjusts dwell and run time to hold the timetable or an even headway after a perturbation.

Turnback · Reversing a train at a terminal or mid-line crossover. Often the true capacity constraint on a converted line.

Junction margin · The spacing reserved at a converging junction so conflicting moves can be sequenced without braking the following train.

POSITION AND ODOMETRY 16 TERMS

Odometry · The onboard estimate of distance travelled, produced by fusing several sensors, each with different failure characteristics.

Tachometer · A wheel-mounted rotation sensor. Accurate but corrupted by wheel slip, slide and wheel-diameter wear.

Doppler radar · A ground-facing speed sensor that is immune to wheel slip, used to bound tachometer error.

Accelerometer · An inertial sensor providing a third, independent estimate for the odometry fusion.

Balise · A passive trackside transponder providing an absolute position reference when the train passes over it, bounding accumulated odometry drift.

Transponder · The generic term for a balise or tag; usage varies by supplier.

Balise reader · The onboard antenna and processor that energizes and reads balises.

Position uncertainty · The interval within which the train's true position is guaranteed to lie. ATP protects against the worst end of it, never the estimate.

Front-of-train / rear-of-train · The two ends of the position uncertainty envelope. Separation is computed from the worst case of each: rear of the leader, front of the follower.

Drift · Accumulated odometry error between balise reads. Its growth rate sets the maximum permissible balise spacing.

Wheel slip / slide · Loss of adhesion in traction or braking, the dominant source of tachometer error and the reason for sensor fusion.

Re-railing / re-localization · Re-establishing a train's confirmed position after it has been lost, typically requiring a balise pass at restricted speed.

Localized / non-localized · Whether a train currently has a valid, bounded position. A non-localized train is protected far more conservatively.

Train integrity · Confirmation that the train is complete and no vehicles have detached. Assumed structurally on most metro fleets; explicitly monitored on others.

Track database · The onboard and wayside model of the alignment: geometry, gradients, speed limits, balise locations and topology.

Guideway · The running way, used in preference to 'track' for automated and rubber-tyred systems.

Radio access point · The trackside radio unit, typically every 250–500 m with overlapping coverage, forming the DCS.

Handover · The transfer of a train's radio association from one access point to the next, or of protection responsibility from one zone controller to the next.

Heartbeat · A periodic health message between train and wayside, or between redundant processors. Its absence for a defined interval triggers a defined fallback.

Latency budget · The end-to-end delay allowance from measurement to enforcement, apportioned across the chain and verified in test.

Jitter · Variation in message delay. Sustained jitter degrades the achievable headway even when average latency is within budget.

Packet loss · Messages lost in transit. The protection design assumes a rate and degrades safely beyond it.

ISM band · The unlicensed 2.4 and 5 GHz spectrum most legacy CBTC radio uses — cheap, and shared with everything else.

LTE-R · Cellular-grade radio adapted for railway use; a migration path away from unlicensed spectrum.

Private 5G · A dedicated cellular network on licensed or shared spectrum, increasingly proposed as the DCS bearer.

FRMCS · Future Railway Mobile Communication System. The European successor to GSM-R; relevant to US agencies mainly through vendor roadmaps.

Inductive loop · The pre-radio train-to-wayside bearer: a cable laid along the track. Still in service on some early systems.

Redundant radio · Two or more independent radio paths per train, so a single antenna or access-point failure does not cost the position report.

Message authentication · Cryptographic verification that a position report or Movement Authority came from the claimed source and was not altered.

Replay protection · Ensuring an intercepted valid message cannot be re-injected later — a basic requirement of any vital protocol.

RSSI · Received Signal Strength Indication. The field measurement used to verify radio coverage along the alignment during SIT.

Coverage survey · The systematic measurement of radio performance along the whole line, which no lab simulator can substitute for.

GoA · Grades of Automation. The IEC 62290-1 framework allocating responsibility across five levels, GoA 0 to GoA 4.

GoA 0 · On-sight operation. The driver drives by line of sight, with no automatic protection.

GoA 1 · Non-automated train operation. The driver drives; ATP supervises and intervenes.

GoA 2 · Semi-automated train operation. ATO drives inside the ATP envelope; the driver closes doors and handles disruption. The US norm.

GoA 3 · Driverless train operation. No driver; an attendant on board manages disruption and evacuation.

GoA 4 · Unattended train operation. No operating staff required on board; disruption and evacuation fall to the control centre and automation.

UTO · Unattended Train Operation — the operational name for GoA 4.

DTO · Driverless Train Operation — GoA 3.

STO · Semi-automated Train Operation — GoA 2.

NTO · Non-automated Train Operation — GoA 1.

Normal mode · Full CBTC operation with a valid Movement Authority and a localized train.

Restricted manual · Driving under a low absolute speed limit with ATP protection reduced or absent; the usual fallback when position is lost.

Degraded mode · Any defined operating state below full CBTC performance, entered deliberately and with a defined exit.

Failure mode · An unplanned state the design must render safe, as distinct from a degraded mode the design provides for.

Fallback · The defined transition from one operating mode to a lower one when a condition is lost.

Mixed mode · CBTC-equipped and non-equipped trains sharing track. Capacity is governed by the least-capable train type.

Shadow mode · CBTC monitoring live traffic and logging decisions without controlling trains. Also called ghost mode.

Degraded-mode ladder · The ordered sequence of fallbacks from normal operation down to restricted manual, each with its own entry and exit criteria.

Wake-up / sleep · Automated start-up and shutdown of an unattended train, including the self-test sequence that must pass before it can move.

Auto-reverse · Automated turnback at a terminal without staff intervention — a GoA 4 requirement and a common capacity constraint.

SIL · Safety Integrity Level. A 1–4 scale of the rigour demanded of a safety function. ATP is SIL 4; ATO is SIL 0–2 depending on GoA; ATS is SIL 0.

SIL 4 · The highest level, corresponding to a tolerable hazard rate between 10^{-9} and 10^{-8} dangerous failures per hour. A design posture and an evidence burden, not a certificate you buy.

THR · Tolerable Hazard Rate. The quantified frequency at which a specified hazard may occur; the numeric target a SIL allocation encodes.

Vital · Any function whose failure can cause a hazard, and which must therefore be implemented to fail safe.

Non-vital · A function whose failure degrades performance but cannot by itself cause a hazard.

Fail-safe · A design property: on failure, the system reaches a state that is safe — usually stopped — rather than an unpredictable one.

Safety case · The structured argument, with evidence, that a system is acceptably safe for a defined use in a defined context.

Hazard log · The living register of identified hazards with their analysis, mitigation and closure status. Auditable throughout the project.

HAZOP · Hazard and Operability study. A structured, guideword-driven group analysis of deviations from design intent.

FMEA · Failure Modes and Effects Analysis. Bottom-up: for each component failure, what happens?

FTA · Fault Tree Analysis. Top-down: for a defined hazard, which combinations of failures produce it? (Not to be confused with the Federal Transit Administration.)

ISA · Independent Safety Assessor. A party independent of the delivery team that assesses the safety case and its evidence.

V&V · Verification and Validation. Verification asks whether the system was built to the requirements; validation asks whether the requirements were the right ones.

RAMS · Reliability, Availability, Maintainability and Safety. The contractual quality attributes of a rail system, per EN 50126.

MTBF · Mean Time Between Failures. Usually specified per subsystem and measured over a defined revenue period.

MTTR · Mean Time To Repair. Combined with MTBF, it sets achievable availability.

Availability · The proportion of scheduled service time the system is capable of delivering. Contractually defined, and the definition matters more than the number.

Common cause failure · A single cause defeating supposedly redundant channels — the failure mode redundancy alone does not address.

Diversity · Deliberately different implementations of the same function so a design fault does not defeat both channels.

2oo2 / 2oo3 · Two-out-of-two and two-out-of-three voting architectures for vital processors; 2oo2 fails safe on disagreement, 2oo3 continues on a majority.

Safe state · The condition the system enters when it can no longer assure safety — typically brakes applied and movement authority withdrawn.

Systematic failure · A failure arising from a design or process fault rather than random hardware failure. Not reducible by redundancy; addressed by process rigour.

STANDARDS AND REGULATORY

18 TERMS

IEEE 1474.1 · Performance and functional requirements for CBTC. The US procurement floor; specifying 'CBTC' without citing it leaves the definition to the vendor.

IEEE 1474.2 · User interface requirements for CBTC.

IEEE 1474.3 · Recommended practice for CBTC system design and functional allocation.

IEEE 1474.4 · Recommended practice for functional testing of CBTC.

IEC 62290-1 · System requirements and the GoA definitions, including the responsibility allocation matrix.

IEC 62290-2 · Functional requirements for ATP, ATO and ATS across the automation grades.

IEC 62290-3 · System requirements specification guidance; later parts extend to cybersecurity and test specification.

EN 50126 · The RAMS lifecycle standard for railway applications.

EN 50128 · Software for railway control and protection systems.

EN 50129 · Safety-related electronic systems for signalling, and the structure of the safety case.

EN 50159 · Safety-related communication in transmission systems — the basis for vital messaging over an open network.

IEC 62443 · The industrial cybersecurity series increasingly cited for rail signalling networks.

FTA · Federal Transit Administration. The federal funder and oversight body for US transit capital projects.

SSO · State Safety Oversight. The state agency with safety jurisdiction over a rail transit system, under FTA rules.

PMOC · Project Management Oversight Contractor. FTA's agent reviewing a funded project's readiness, including the System Integration Review gate.

CIG · Capital Investment Grant. The FTA funding programme whose requirements shape scope, schedule and reporting.

Buy America · The domestic-content requirement attached to federal funding; all tier-1 CBTC suppliers maintain US facilities to satisfy it.

APTA · American Public Transportation Association. Publishes industry standards and recommended practice used across US procurement.

RFP · Request for Proposal. The document whose specification quality determines most of what follows.

ICD · Interface Control Document. The per-interface specification of message formats, timing, failure modes and acceptance criteria. Its absence is the most reliable predictor of schedule slip.

Performance-based specification · A specification stating required outcomes — headway, availability, latency — rather than prescribing an implementation.

Prescriptive specification · A specification dictating the design. Reduces vendor freedom and transfers design risk to the owner.

Bundled procurement · Signalling and rolling stock (or civils) procured under one contract, giving single-prime accountability for integration.

Unbundled procurement · Separate contracts per scope. Cheaper on paper; the integration risk returns to the owner.

Single-prime · One contractor accountable for the integrated outcome, as on the Honolulu Skyline vehicle-and-signalling contract.

Owner's engineer · The owner's technical representative with the standing to reject a vendor interpretation. Its absence is felt at design review.

PMC · Program Management Consultant. Represents the owner in schedule, cost and technical oversight.

Liquidated damages · Pre-agreed sums payable for defined failures to perform, structured before award rather than negotiated after.

Performance guarantee · A contractual commitment to a measurable outcome, typically headway and availability, with a defined demonstration method.

Vendor lock-in · The condition where the platform choice makes future work non-competitive. In CBTC it is structural, not accidental, which is why data rights belong in the RFP.

Data rights · Ownership of and access to interface definitions, configuration data and logs — the practical determinant of whether a second supplier can ever bid.

Second source · A viable alternative supplier for a component or scope. Common in fixed-block signalling, rare in CBTC.

Change order · A contractual variation. The instrument through which under-specified interfaces become expensive.

Scope of work · The definition of what is being bought. Where an ICD is absent, the SOW is where that gap will surface.

Basis of design · The stated assumptions the design is built on — fleet, timetable, alignment — which every later dispute returns to.

Contingency · Budgeted allowance for identified risk. On brownfield CBTC it is consumed disproportionately by interface and access issues.

V-model · The development lifecycle pairing each specification level with the test level that verifies it.

FAT · Factory Acceptance Test. Vendor lab, 6–12 weeks, typically 60–90 percent functional coverage of the final system.

SIT · Site Integration Testing. On site with real hardware, radio and geometry; typically 12–20 weekends on a mid-size line.

Dynamic testing · The first train movements under CBTC control, progressing through defined scenarios; typically 4–8 weeks.

Shadow running · CBTC logging live traffic without controlling it. Best practice on US brownfield is 6–12 months.

Parallel operations · CBTC and legacy trains sharing track during transition; typically 2–8 weeks.

RSD · Revenue Service Demonstration. Full CBTC control with passengers at limited service levels, 2–4 weeks before full cutover.

HIL · Hardware-in-the-Loop. Production code run against a simulated railway, allowing repeatable and otherwise unsafe scenarios.

Simulator · A full-system model of track, trains and wayside used to validate thousands of scenarios before on-track testing. Reduces on-track time; does not replace it.

Cutover · The transition from legacy signalling to CBTC. The highest-risk event in the lifecycle — it does not create problems, it reveals them.

MOP · Method of Procedure. The minute-by-minute choreography of the cutover window. A good one runs 60–100 pages; a 15-page MOP manufactures false confidence.

Cutover rehearsal · A full dress rehearsal 4–6 weeks before the event with the same staff, equipment and timeline.

Rollback criteria · The pre-defined, objective conditions under which the cutover is abandoned and the legacy system restored. Decided before the window, not inside it.

War room · The command centre during cutover, with named roles and pre-assigned decision authority — including who may stop it.

Big bang · Full-line conversion in one extended shutdown, typically 3–7 days. Defensible on greenfield; rarely on an operating urban line.

Segment-phased · Conversion by geographic section over weeks or months. The most common US brownfield strategy.

Fleet-phased · Retrofit by depot or batch over 18–36 months, with a correspondingly long mixed-mode period.

Function-phased · ATP first, ATO later, each with its own cutover and ramp.

Burn-in · The first 30–90 days of revenue service, run as a managed ramp with reduced schedule and vendor engineering on site.

Punch list · The register of outstanding defects at handover, each with an owner and a closure date.

System boundary · Per IEC 62290, the CBTC system comprises ATP, ATO and ATS — and nothing else. Everything beyond it is external infrastructure behind an interface.

PSD · Platform Screen Door. Full- or half-height barriers at the platform edge, mandatory in practice for GoA 4. Operates on independent position sensing, not on CBTC's word.

PED · Platform Edge Door. A half-height variant of PSD.

SCADA · Supervisory Control and Data Acquisition. Traction power, ventilation and station plant; interfaces with CBTC for power status and regenerative braking coordination.

PIS · Passenger Information System. Consumes ATS predictions to drive platform and in-car displays.

AFC · Automatic Fare Collection. Outside the boundary, but shares station infrastructure and sometimes the same network.

BAS · Building Automation System. Station environmental and plant control.

Depot management · Stabling, washing and maintenance movements. Often the last scope to be automated and a frequent source of late change.

OPC-UA · A vendor-neutral industrial protocol commonly used for the SCADA interface.

Hardwired interface · A relay-level connection. Absolutely fail-safe, inflexible, and still the right answer for some interlocking interfaces.

Gateway · A translating device between a legacy protocol and the CBTC. Its ownership — vendor or owner — must be settled in the contract.

Legacy overlay · CBTC installed over retained conventional signalling, which remains available as a fallback.

Greenfield · A new line with no inherited signalling, operating rules or fleet constraints.

Brownfield · Conversion of an operating railway. The brownfield tax — access, interfaces, mixed running — is what makes international unit costs travel badly.

Track circuit · The legacy train-detection method: wheels short a rail-borne circuit. Retained in CBTC territory only where interlocking or fallback requires it.

Axle counter · An alternative detection method counting axles into and out of a section; less susceptible to rust and shunt problems than a track circuit.

Trainguard MT · Siemens Mobility's CBTC platform. NYCT Line 7 and the L Line; Paris Line 1.

SelTrac · The CBTC platform originating with Alcatel, then Thales, and part of Hitachi Rail since May 2024. Vancouver SkyTrain, London Jubilee, BART TCMF.

Urbalis · Alstom's CBTC platform, incorporating the former Bombardier CITYFLO line after the 2021 acquisition.

CITYFLO · Bombardier's CBTC family, now within Alstom. CITYFLO 650 is the moving-block variant.

Ansaldo STS · The Italian signalling house behind Copenhagen's driverless metro, now part of Hitachi Rail.

CRSC / TCT · Chinese suppliers dominating domestic metropolitan CBTC, with an estimated 15–20 percent of the global market and effectively no North American presence.

PTC · Positive Train Control. The US mainline overspeed and signal-enforcement mandate. Not CBTC: fixed-block, far coarser, different regulator.

I-ETMS · Wabtec's interoperable PTC platform, deployed across roughly 15,000 km of US freight railroad.

ERTMS · European Rail Traffic Management System — the mainline framework of which ETCS is the train-control component.

ETCS · European Train Control System. Level 2 is radio-based with fixed blocks; Level 3 approaches moving block. Mainline, not metro.

Hybrid Level 3 · An ETCS variant subdividing fixed blocks using train-reported position — conceptually adjacent to CBTC, on mainline infrastructure.

Virtual coupling · A research-stage concept in which trains run at absolute-braking-distance separation by exchanging state train-to-train. Not deployed in revenue service.

