Volume 2

CHAPTER 10

CBTC in the United States

Communications-Based Train Control
A Comprehensive Guide for US Transit Professionals
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Chapter Overview

- Ground CBTC theory in concrete US deployment experience — what worked, what cost more, and what it means
- Six case studies span NYC L Line (2006) through Honolulu Skyline GoA 4 (2023)
- Examine realistic cost escalations, schedule variances, and labor engagement strategies
- Survey emerging projects: WMATA, SEPTA, CTA, and the airport APM sector
- Part IV opening chapter — US Deployment and Case Studies

US CBTC Deployment Map

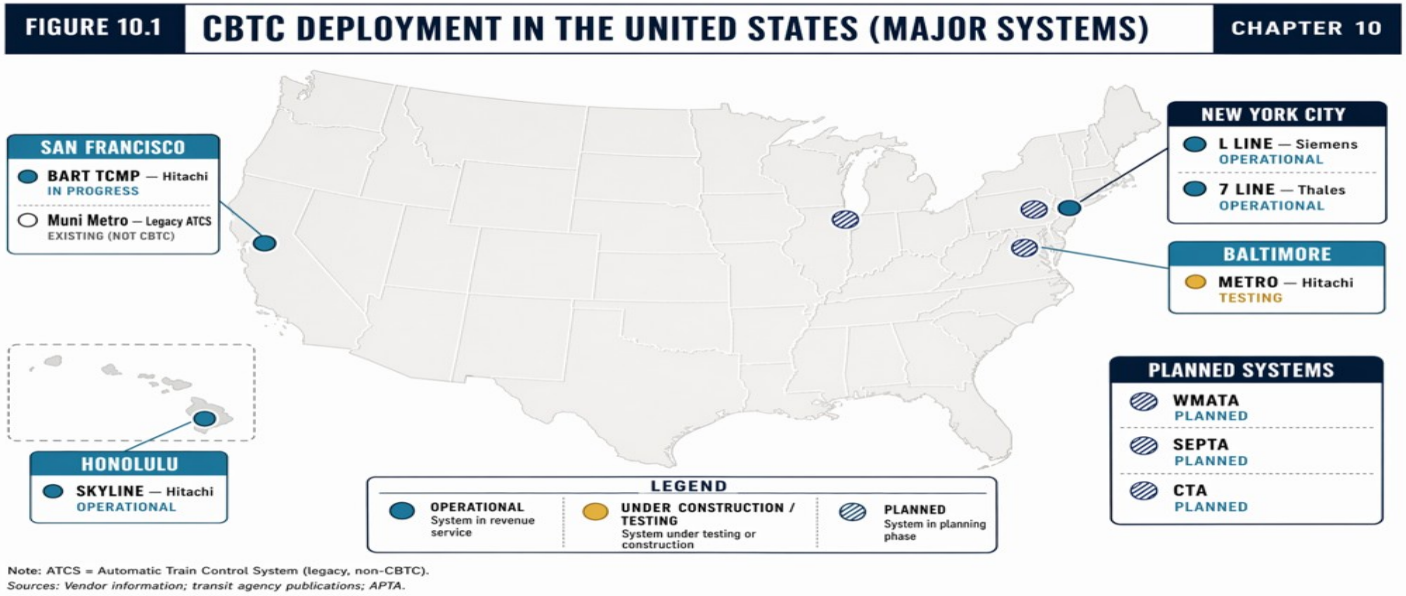

Figure 10.1 — Geographic map of current and planned US CBTC deployments.

10.1

NYC MTA: The L Line — America's CBTC Pioneer

L Line CBTC Performance Gains

2×

capacity

Peak throughput: 15 → 30 tph

93–95%

OTP

On-time performance (vs. 85% pre-CBTC)

99%+

availability

System availability post-stabilization

L Line: Challenges & Lessons

- Overlay deployment on legacy fixed-block: complex but feasible
- 3-year testing phase (2006–2009) — budget for extended validation
- TWU Local 100 labor negotiations concluded 2005 — early, transparent engagement
- Hurricane Sandy (2012) caused catastrophic tunnel flooding

- Final cost ~$500M vs. $340M baseline (+47% overrun)
- 12–15% energy savings from ATO-optimized speed profiles
- Mixed-fleet R143/R160 interoperability required extensive work
- 20-year Siemens partnership (1999–present) critical to success

US CBTC Deployment Timeline

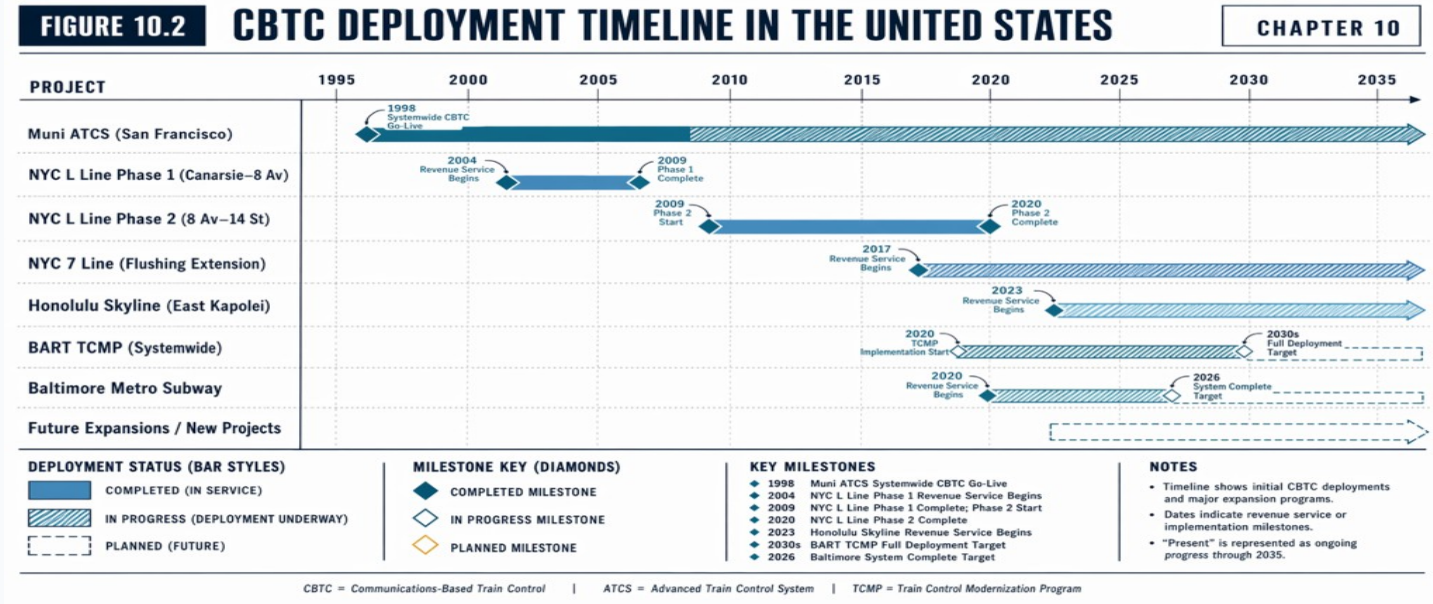

Figure 10.2 — Timeline of major US CBTC project milestones from 1999 to present.

10.2

NYC MTA — CBTC Expansion Program

NYC CBTC Expansion: Scale & Ambition

- 248 miles of route, 472 stations — the largest CBTC capital deployment in US history
- 7 Line (Flushing): 2nd full CBTC deployment, 29 tph, completed November 2018 (Thales SelTrac)
- Queens Boulevard (E, F, M, R): Siemens Mobility, multi-phase deployment through 2030+
- Culver Line (F, G) and 8th Avenue (A, C, E): in design and early construction phases
- Original $15–30B program projected into the 2040s; 24/7 operations create testing access paradox

US CBTC Project Comparison Matrix

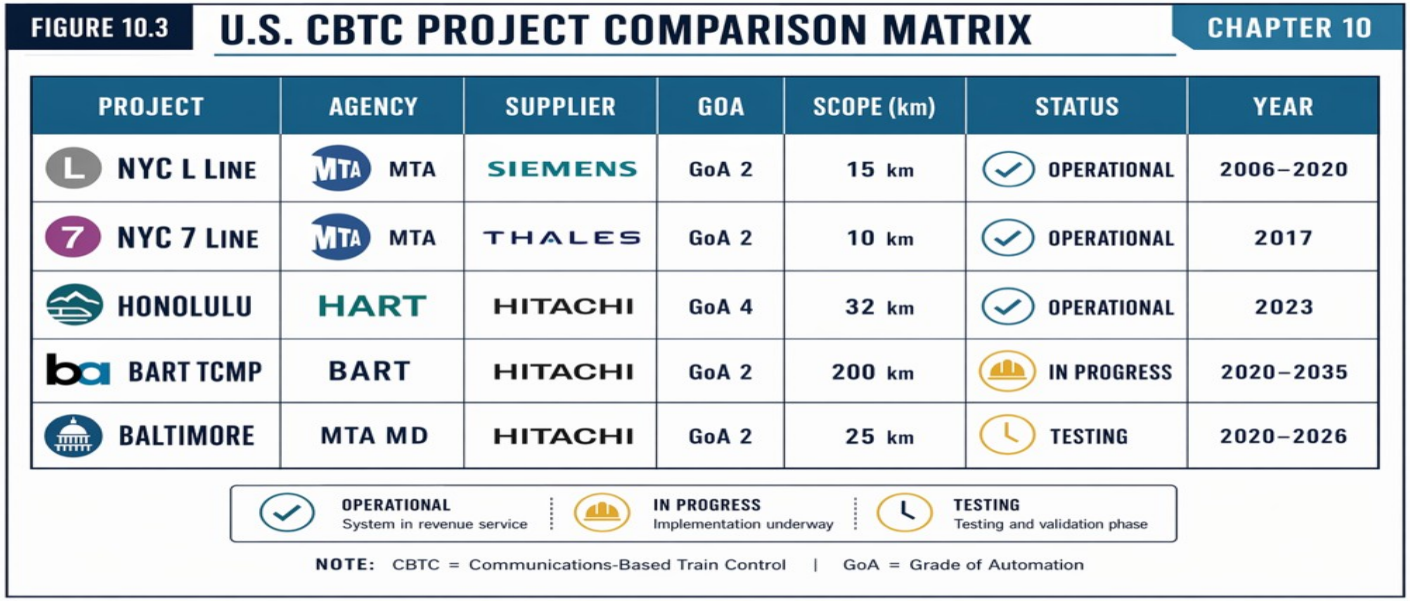

FIGURE 10.3 U.S. CBTC PROJECT COMPARISON MATRIX CHAPTER 10

PROJECT	AGENCY	SUPPLIER	GOA	SCOPE (km)	STATUS	YEAR
NYC L LINE	MTA	SIEMENS	GoA 2	15 km	OPERATIONAL	2006–2020
NYC 7 LINE	MTA	THALES	GoA 2	10 km	OPERATIONAL	2017
HONOLULU	HART	HITACHI	GoA 4	32 km	OPERATIONAL	2023
BART TCMP	BART	HITACHI	GoA 2	200 km	IN PROGRESS	2020–2035
BALTIMORE	MTA MD	HITACHI	GoA 2	25 km	TESTING	2020–2026

OPERATIONAL — System in revenue service
IN PROGRESS — Implementation underway
TESTING — Testing and validation phase

NOTE: CBTC = Communications-Based Train Control | GoA = Grade of Automation

Figure 10.3 — Comparison matrix of US CBTC project scope, cost, and schedule outcomes.

NYC MTA CBTC Expansion Map

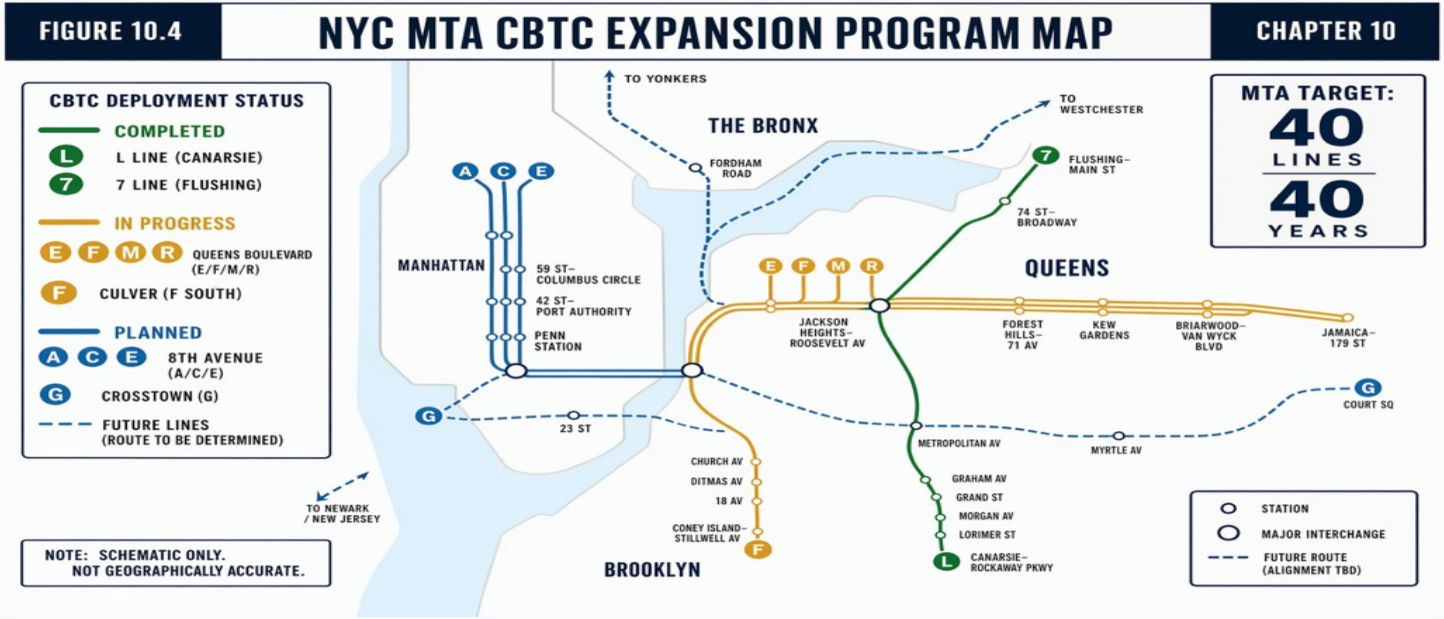

Figure 10.4 — NYC MTA CBTC expansion program: line-by-line deployment status and timeline.

10.3

San Francisco BART — Train Control Modernization

BART TCMP: Complete System Replacement

- 131 miles, 50 stations — full replacement of 1972-era ATC system
- Hitachi Rail STS SelTrac: $798M design-build contract (Jan 2020)
- Target: 30 tph through Transbay Tube (vs. 24 tph current)
- 8-phase geographic deployment prioritizing simpler corridors first

- Transbay Tube: 4.5-mile underwater tunnel — specialized radio engineering
- Fleet of the Future: 775 new Alstom railcars, CBTC-ready from manufacture
- Original target 2022 → revised to 2029–2032 (realistic for 24/7 operations)
- Lifecycle cost exceeds $1.5B over 20 years

BART TCMP Phased Deployment

Figure 10.5 — BART Train Control Modernization Program phased deployment strategy.

10.4

San Francisco Muni: TCUP

Muni TCUP: Hybrid System Retrofit

- 71-mile hybrid network: underground subway + at-grade surface streetcar — unique CBTC challenge
- Hitachi Rail STS: ~$195–220M contract for system-wide replacement
- Central Subway (Phase 1) opened Nov 2022 under production Hitachi CBTC
- Surface operation requires zoned speed control, traffic signal coordination, crossing detection
- Breda LRV retrofit kits + Siemens LRV4 (CBTC-ready) — mixed-fleet transition

10.5

Baltimore Metro: Bundled Procurement Model

Baltimore: Single-Vendor Modernization

- 15.5-mile single-line system, 14 stations — Hitachi Rail: $398M combined contract
- 78 new railcars + complete CBTC signaling from one integrator
- Single-prime accountability eliminates inter-vendor finger-pointing
- Co-designed compatibility: vehicles engineered for Hitachi CBTC from inception
- Model for mid-sized agencies with constrained engineering resources

10.6

Other US Systems and Emerging Projects

Emerging US CBTC Landscape

- Honolulu Skyline (HART): First US GoA 4 heavy metro, opened June 2023
- WMATA: 117 miles, 98 stations — planning/vendor-selection phase for CBTC
- SEPTA: Broad Street Line modernization — CBTC planned late 2020s
- CTA: Red Line focus, expected RFP within 1–2 years

- Airport APMs: universal GoA 4 CBTC — JFK, SFO, ATL, DEN, MIA
- Las Vegas Monorail & Miami Metromover: mature GoA 4 operations
- NYC 2nd Ave Subway Phases 2–4: CBTC-ready infrastructure
- Federal IIJA funding + aging infrastructure = opportunity and urgency

US Airport APMs: GoA 4 CBTC Fleet

System	Airport	GoA	Vendor	Headway
JFK AirTrain	New York JFK	4	Bombardier	3–4 min
SFO AirTrain	San Francisco	4	Bombardier	3–5 min
ATL Skytrain	Atlanta	4	Siemens	4 min
Dulles AeroTrain	Washington	4	MHI	3 min
DIA Airport Train	Denver	4	Bombardier	2–3 min
MIA Mover	Miami	4	Bombardier	2–3 min

US CBTC Cost & Schedule Variance

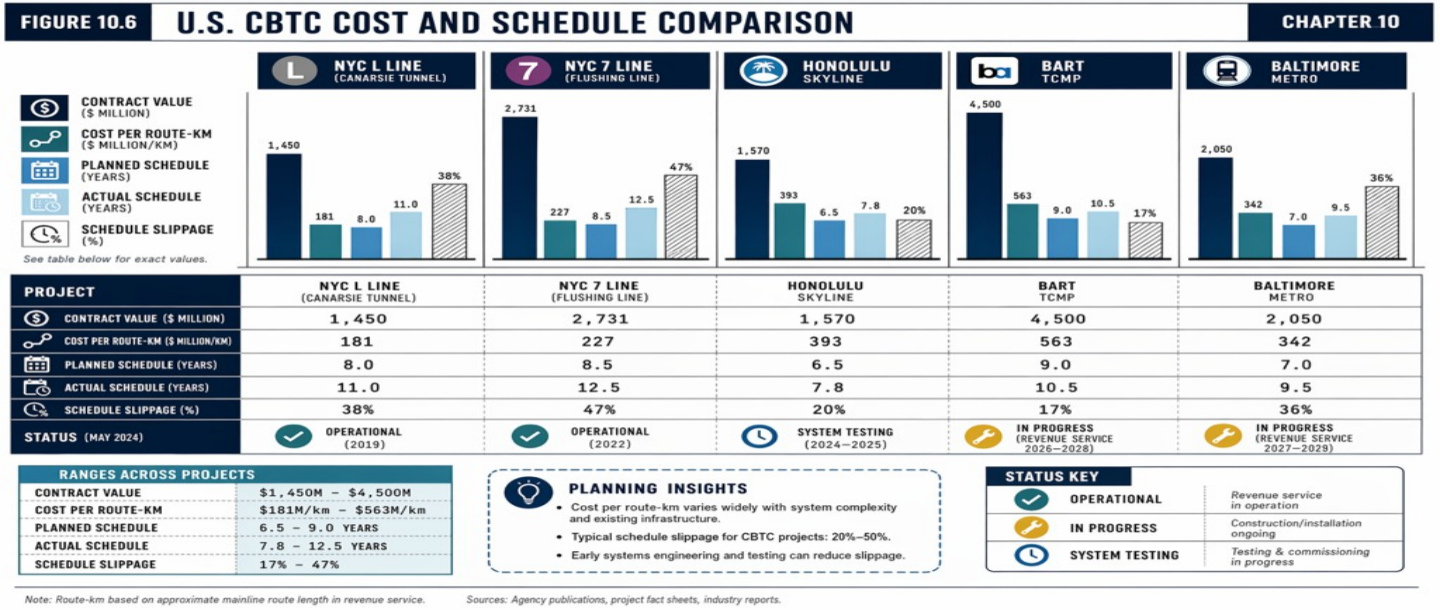

Figure 10.6 — US CBTC project cost escalation and schedule variance comparison.

Key Takeaways

1. CBTC on US revenue lines delivers measurable, sustained benefits — NYC L Line achieved 26–29 tph with 93–95% OTP; the 7 Line reached 29 tph
1. Retrofit of legacy systems is substantially more complex and costly than new-build; BART's 2022 target shifted to 2029–2032 with $1.5B+ lifecycle cost
1. Phased commissioning and mixed-fleet operation during transition are standard practice across all major US deployments
1. Honolulu Skyline proves GoA 4 is technically viable and operationally sound in the US, establishing regulatory and labor precedent
1. Federal IIJA funding combined with aging infrastructure creates a 5–8 year window for 3–5 major US agencies to enter CBTC revenue service

End of Chapter 10

Next: **Chapter 11: International Benchmarks with US Relevance**

Questions & Discussion