Volume 1

CHAPTER 7

Central System — ATS and Operations Control

Communications-Based Train Control
A Comprehensive Guide for US Transit Professionals
Francisco Wang

Chapter Overview

- ATS is the operational "brain" of CBTC — the central intelligence that coordinates train movements across the network
- ATS is non-vital (not safety-critical) but operationally critical: it proposes, ATP disposes
- Explore core ATS functions: timetable management, automatic route setting, schedule regulation, disruption recovery
- Examine the Operations Control Center (OCC) — human-machine interface, alarm management, and backup facilities
- Understand SCADA integration, external system interfaces, and data analytics for continuous improvement

7.1

ATS Functional Overview

ATS Functional Architecture

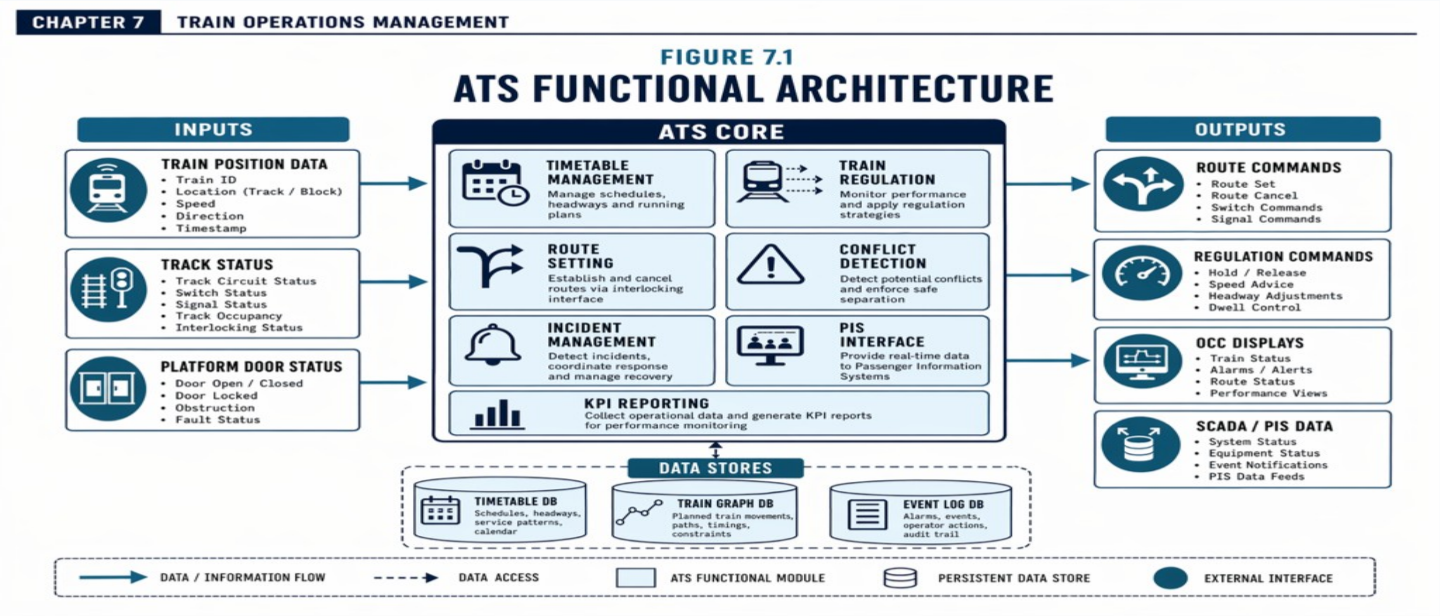

Figure 7.1 — ATS sits above ATP/ATO in the control hierarchy: ATS proposes strategy, ATP enforces safety.

Core ATS Functions

- Timetable Management: digitized schedules with time-of-day, day-of-week, and holiday variants; seamless rollover
- Automatic Route Setting (ARS): computes conflict-free paths through switches, crossings, and platforms
- Schedule Regulation: headway control (peak) vs. schedule adherence (off-peak) with predictive algorithms
- Dwell Time Control: dynamic adjustment using door sensors and platform occupancy data
- Disruption Recovery: add/remove service, short-turns, express operation, platform reassignment

ATS Control Hierarchy

- ATS → Zone Controller → VOBC: strict multi-layer command flow
- ATS formulates supervision commands (route, headway, target speed)
- Zone Controller translates to track-level actions (switches, signals)
- VOBC validates against ATP rules before executing

- ATS proposes, but ATP disposes — safety override is absolute
- Communication loss: trains continue on last assigned route/headway
- Degraded modes: zone failure → legacy interlocking, ATS failure → manual dispatch
- Resynchronization after recovery takes 2–5 minutes

ATS Performance Impact: NYC L Line

75

sec

Post-CBTC headway (was 90 sec)

94%

Schedule adherence (was 78%)

28

sec

Median dwell time (was 35 sec)

ATS Vendor Platforms in US CBTC Deployments

Vendor	ATS Platform	Notable US Deployments	Key Strengths
Siemens	Vicos OC	NYC L, SF Muni	Schedule regulation, rich analytics
Thales	ARAMIS	BART (network-wide)	Multi-line support, resilient architecture
Hitachi	SelTrac Central	Limited US deployments	Integrated ATS/TMS
Alstom	Iconis	Proposed future projects	Cloud-ready analytics

7.2

Control Center Design and Workstations

OCC Information Flow

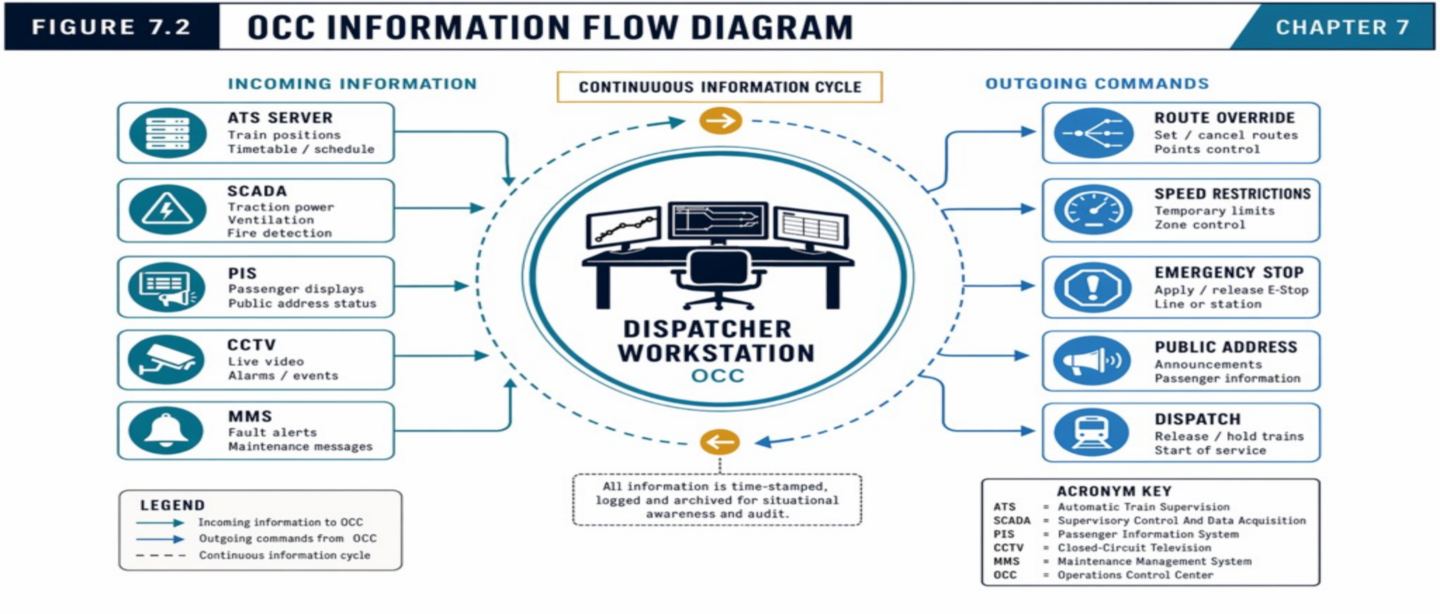

Figure 7.2 — Data flows between ATS, dispatchers, external systems, and train operators.

Dispatcher Workstation Design

- 3–6 monitors per workstation: primary line map, train detail, alarm summary, auxiliary displays
- Information hierarchy: critical data at eye level/center, secondary at arms' reach, tertiary on demand
- Touchscreen for exploratory tasks; physical controls (keyboard, trackball) for safety-critical commands
- HMI follows ANSI/HFES 100 and ISO 11064 ergonomic standards for fatigue reduction
- Role-based configurations: primary dispatcher, power controller, station manager each get tailored views

Dispatcher Workstation Layout

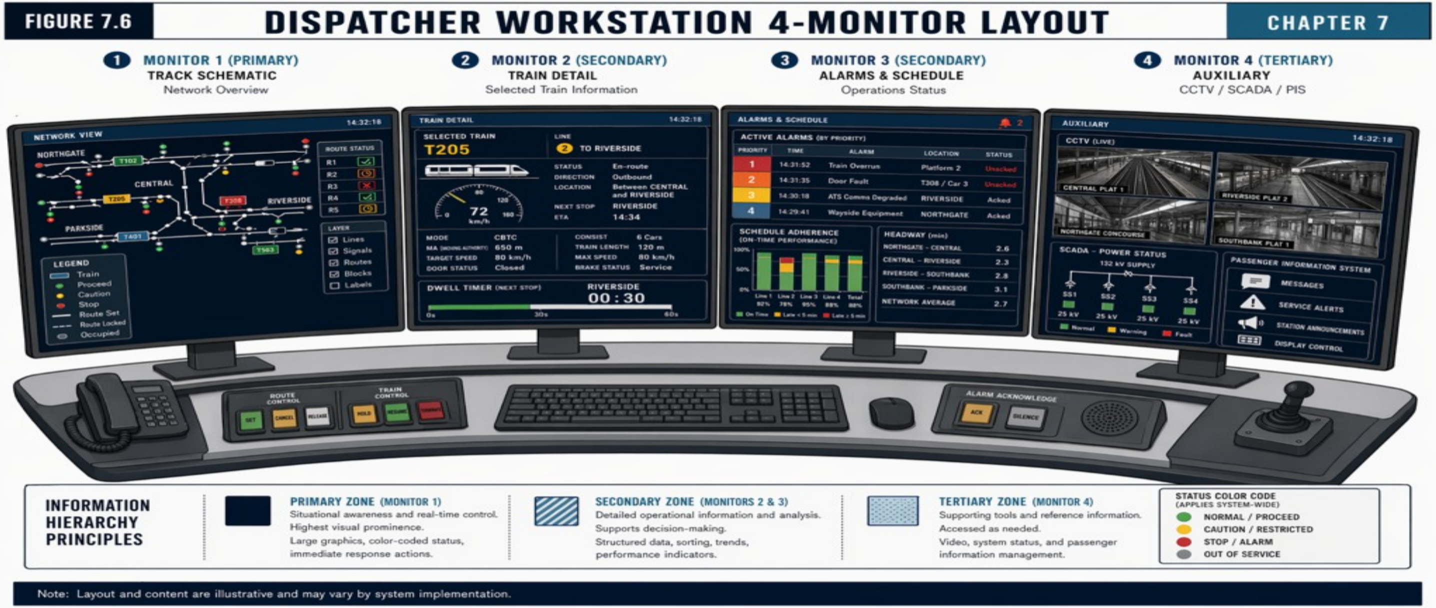

Figure 7.3 — Typical 4-monitor dispatcher workstation with information hierarchy design.

Alarm Management and Backup Control

- ISA 18.2 three-tier alarm philosophy: Critical (red/flashing), Major (yellow), Minor (blue/gray)
- Alarm flooding prevention: root-cause correlation, suppression rules, rate limiting
- Two-step acknowledgment for safety-critical alarms prevents inadvertent clearing
- All acknowledgments logged with timestamp and operator ID

- Backup Control Center (BCC): geographically separated (10+ miles)
- Cold standby: 30 min–hours activation; warm standby: 5–15 min
- Hot standby (active-active): <1 min switchover for fully automated lines
- Continuous data replication + quarterly failover exercises

7.3

SCADA and External System Interfaces

The Transit System Ecosystem

- Power SCADA: real-time section energization status; IEC 60870-5-104, DNP3, IEC 61850 protocols
- Fire & Life Safety: NFPA 130 mandates — auto-deny train entry to fire zones, emergency ventilation coordination
- Passenger Information: GTFS-Realtime feeds for dynamic message signs, PA systems, mobile apps
- Building Automation: HVAC, lighting, elevator status — indirect integration for demand prediction
- Fare Collection: service interruption coordination, entrance gate management, enterprise service bus pattern

ATS External System Integration

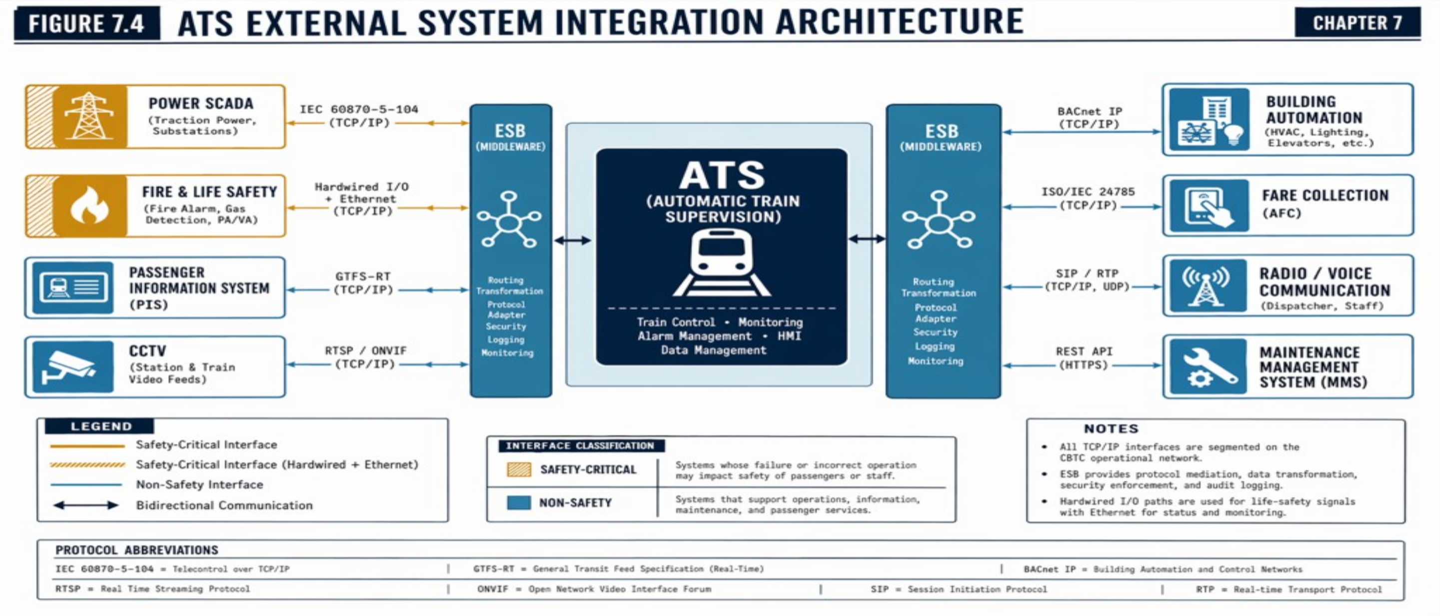

Figure 7.4 — ATS interfaces with power SCADA, fire/life safety, passenger info, surveillance, and fare systems.

7.4

Data Analytics and Performance Monitoring

The CBTC Data Firehose

200-500
GB/day

Peak-hour data volume (medium metro)

1-4
Hz

Position report frequency per train

50-200
TB

Warm operational data storage

Analytics Driving Continuous Improvement

- Headway & throughput analysis: actual vs. design tph, bunching detection, bottleneck identification
- Schedule adherence: station-to-station OTP — CBTC achieves 93–98% vs. 85–92% for legacy systems
- Energy management: ATO coasting algorithms reduce consumption 10–15% vs. manual driving
- Predictive maintenance: trend analysis of sensor data forecasts failures days/weeks in advance
- Dwell time statistics by station and time-of-day reveal root causes of capacity shortfalls

Data Analytics Loop

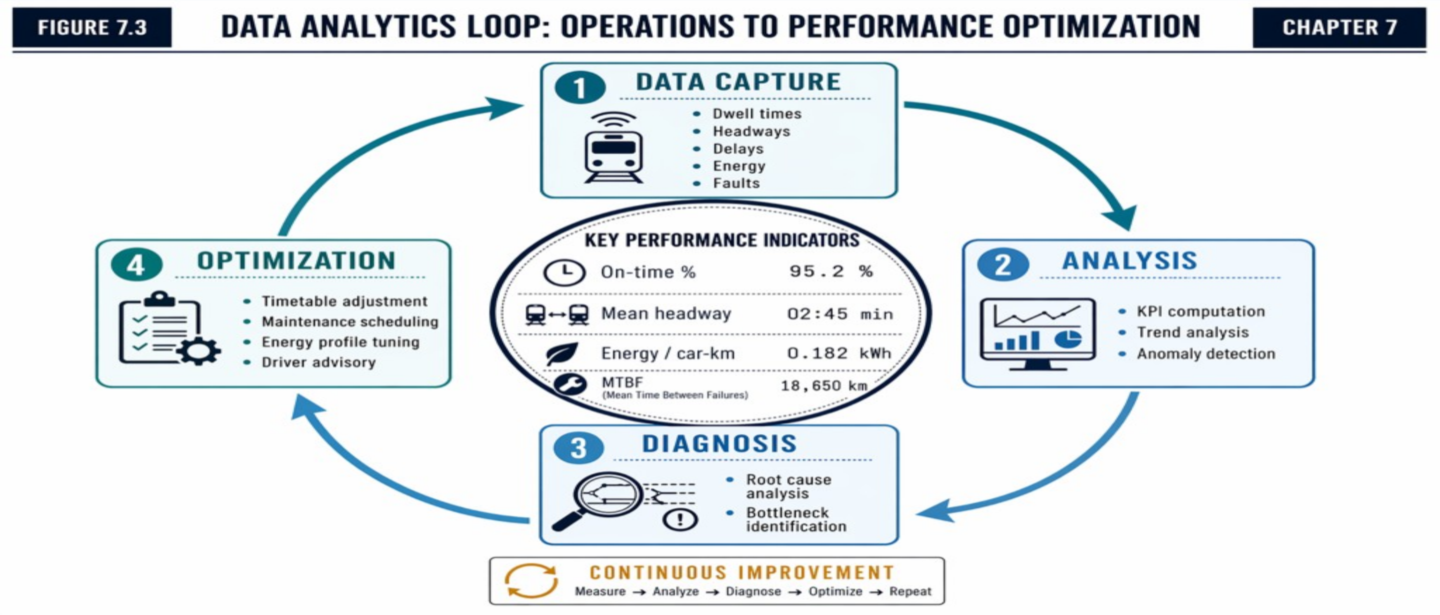

Figure 7.5 — Closed-loop data pipeline: operations → analytics → optimization → improved operations.

Predictive Maintenance Pipeline

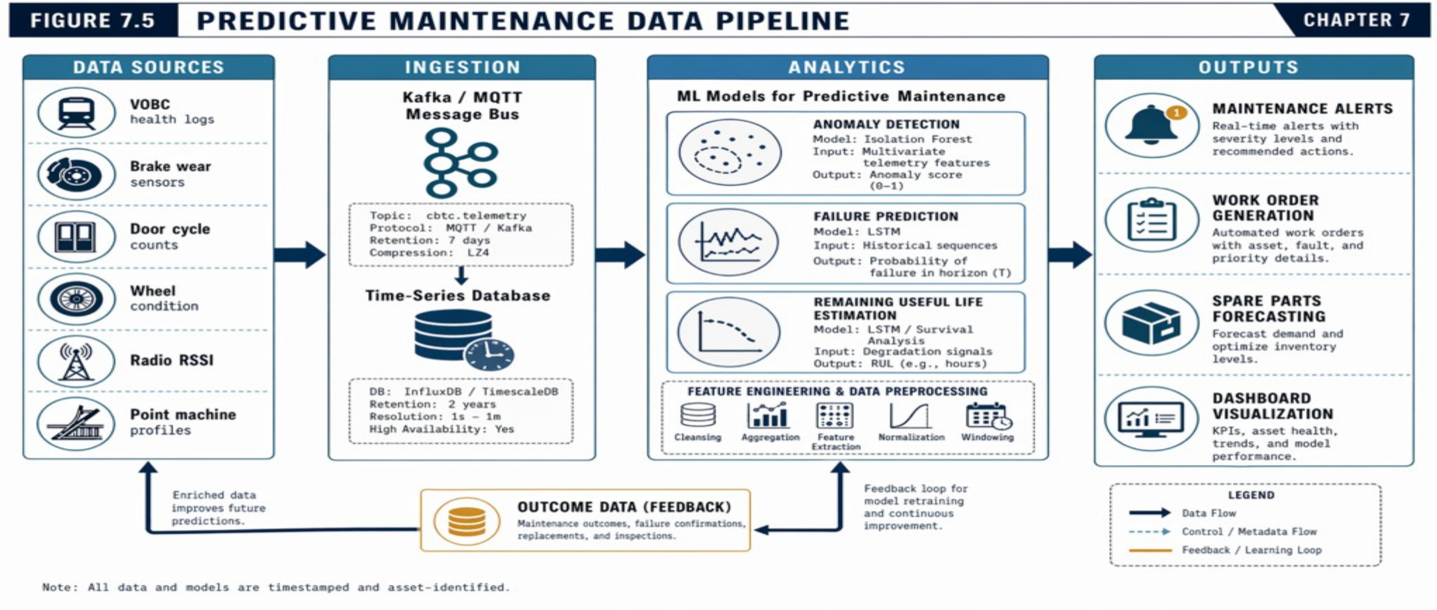

Figure 7.6 — Sensor data feeds predictive models that trigger proactive maintenance before failure.

Key Takeaways

1. ATS is the operational brain of CBTC — non-vital but critical for schedule adherence, headway optimization, and disruption recovery

1. Core functions (timetable, ARS, regulation, dwell control) enabled the NYC L Line to cut headway from 90 to 75 seconds

1. Modern OCCs require ergonomic workstations, ISA 18.2 alarm management, and geographically separated backup facilities

1. External integration (power SCADA, fire/life safety, passenger info) through enterprise service bus patterns reduces complexity

1. CBTC generates 200–500 GB/day of operational data — analytics platforms transform this into capacity, safety, and maintenance gains

End of Chapter 7

Next: **Chapter 8: Grades of Automation (GoA 0–4)**

Questions & Discussion

