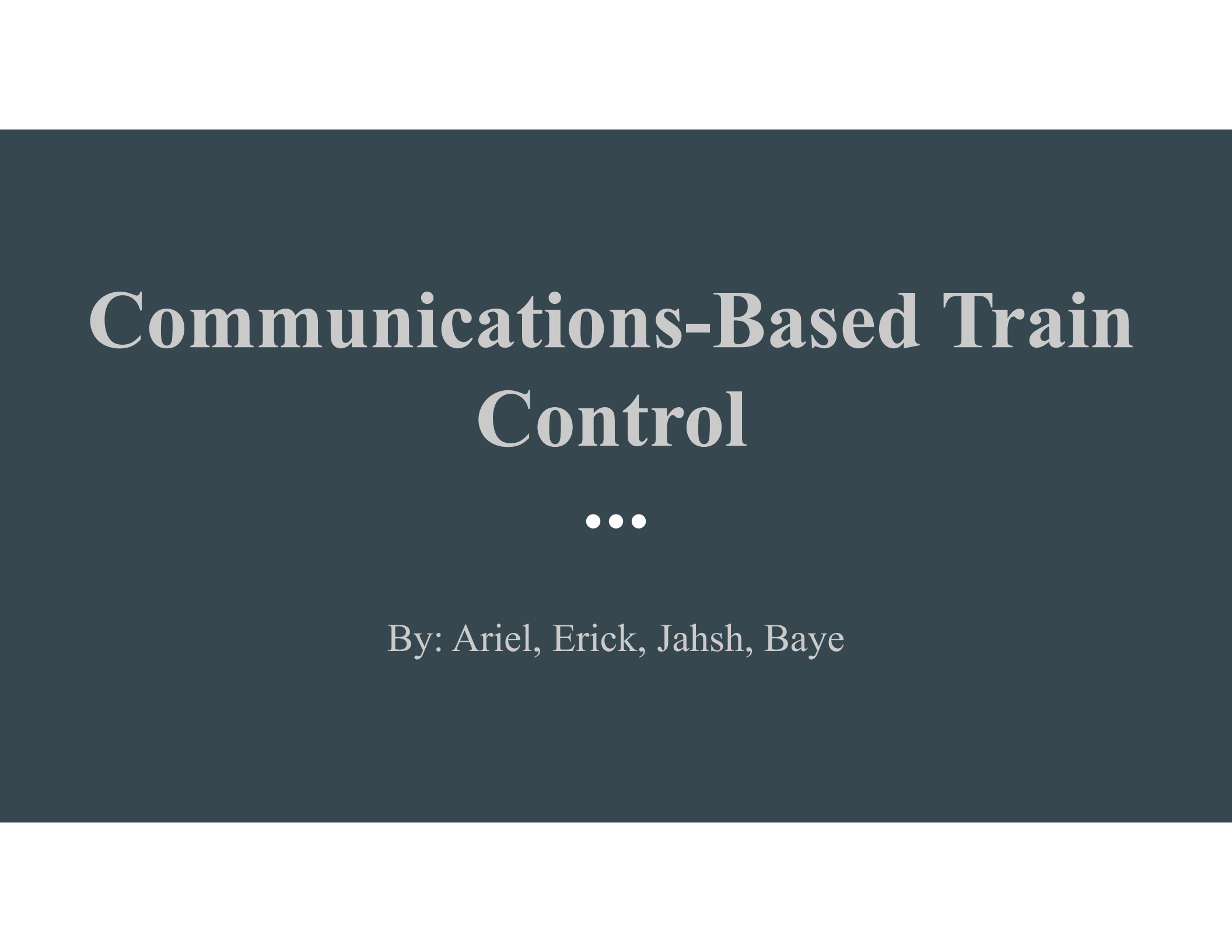
Communications-Based Train Control



By: Ariel, Erick, Jahsh, Baye

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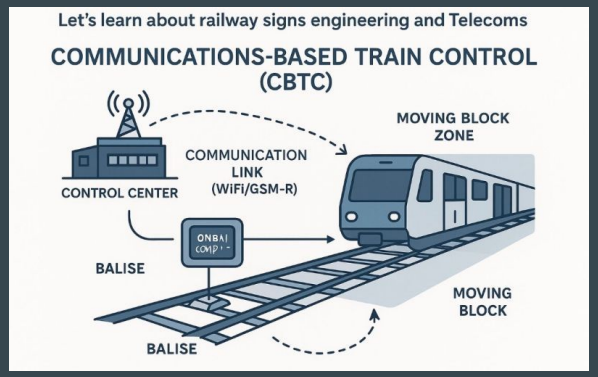
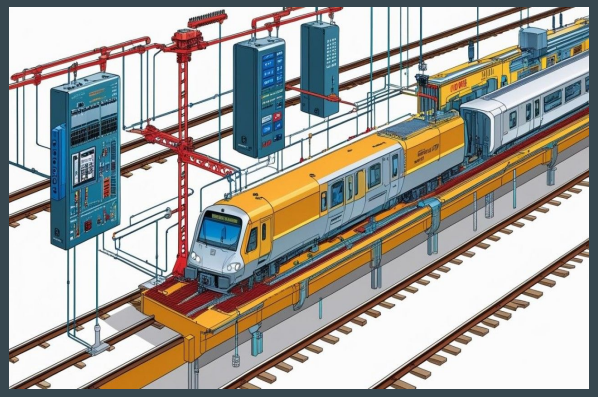




Intro / Problem

- Train system is very slow
- Light system and communications fails a lot
- We wanted to make a system that is more reliable and faster for users
- Lack of a reliable and advanced subway system.

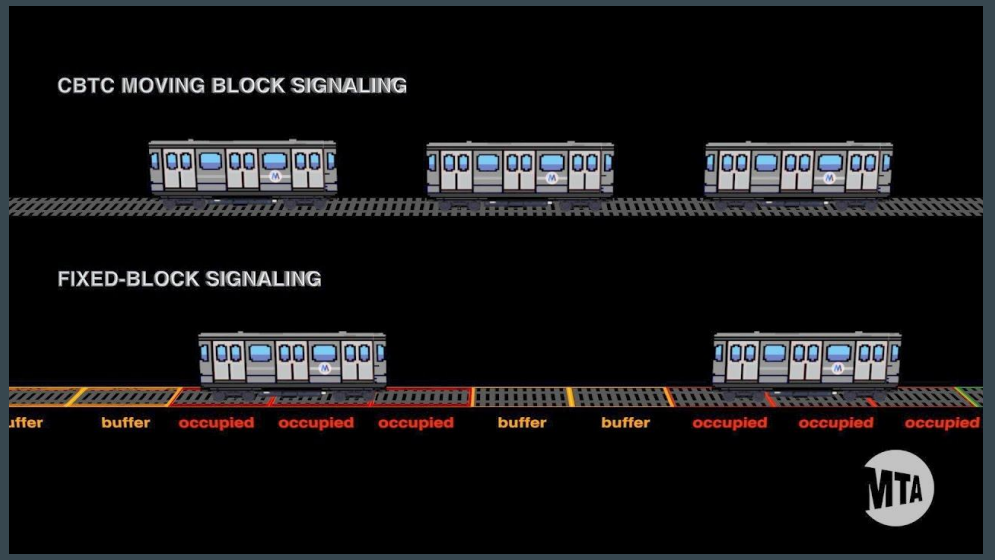
Previous Attempts and Our Solution

Enhanced Subway Program of 2016:

- Focused on Cosmetic Upgrades
- Did Not Address Train coordination and Signalling
- Extensive Infrastructure Decay Delayed the Project

CBTC:

- Utilises Live Wireless Communication Between Trains
- Fixed “Blocks” Are Replaced with Dynamic “Blocks”
- Maintains Consistent Spacing Between Trains



Costs

Cost of Fixing Subway Delays (CBTC System):

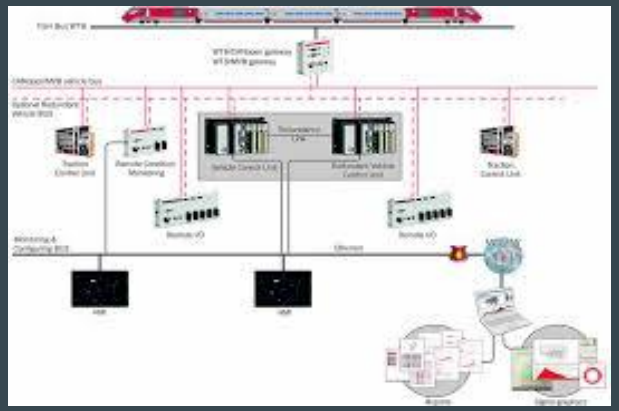
- $25 Million per mile (signal)
- $12-15M per train car
- 50 miles = $1.25 Billion
- Station: $28M-$43M each

Why so expensive:

- New digital System (CBTC)
- Removing old signals
- Complex underground work
- Advanced tech + high labor costs

Materials and resources

- Zone Controllers(Temp)
- Antennas (RF)
- Train Control Management System
- Radars
- Locking-systems
- Engineers/contractors



NYC SUBWAY CBTC TRAIN CONTROL SYSTEM

Communication-Based Train Control (CBTC) replaces fixed wayside signals with real-time communication to safely move trains more efficiently.

HOW CBTC WORKS (OVERVIEW)

1. Train detects its exact position and speed.
2. Info is sent via wireless radio to wayside equipment and the control center.
3. The system calculates a safe speed and movement authority (moving block).
4. Commands are sent back to the train (speed limit, route, permissions).
5. The train automatically adjusts speed. If needed, ATP applies brakes to keep the train safe.

CBTC = MOVING BLOCK

Trains are sparated in real time based on their exact position, allowing closer headways and more service.

MAIN COMPONENTS & PARTS

1. ONBOARD TRAIN EQUIPMENT

Installed on each train.

- Onboard Computer (OBC)
- ATP (Automatic Train Protection)
- ATO (Automatic Train Operation) – where used
- DMI (Driver Machine Interface) / Cab display
- Radio (Wi-Fi)
- Speed & position sensors (odometer, accelerometer)

2. WAYSIDE EQUIPMENT

Located along the track.

- Wayside Radio Units (Wi-Fi)
- Zone Controllers (trackside computers)
- Transponders / Balises (position reference points)
- Axle Counters (train detection)
- Switch Controllers
- Power & equipment cabinets

3. COMMUNICATION NETWORK

Provides continuous two-way data.

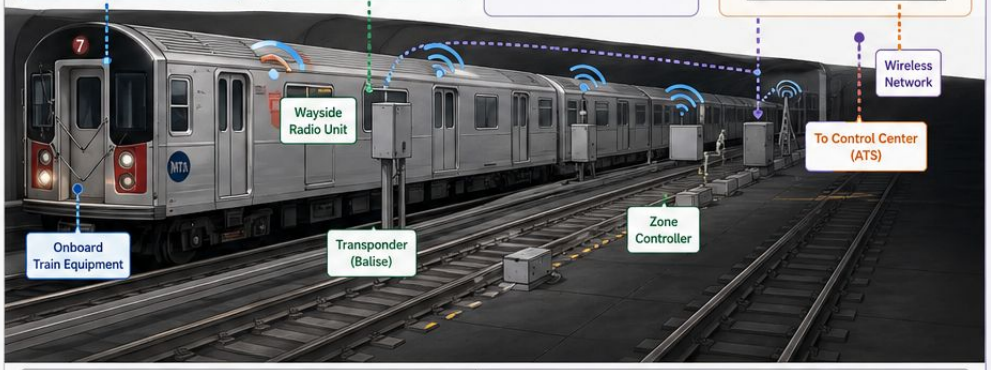
- Redundant Wi-Fi network (5 GHz)
- Leaky feeder / fiber backhaul
- Wayside to train and wayside to control center links

4. CENTRAL CONTROL

(ATS – AUTOMATIC TRAIN SUPERVISION)

Syrain that monitors and manages all train movements.

- Servers & applications
- Real-time train tracking
- Movement authority calculation
- Speed commands
- Route setting & interlocking
- Alarm monitoring & logging
- Operator workstation displays



CENTRAL CONTROL CENTER

KEY BENEFITS

- **Higher Capacity** — Trains run closer together safely, reducing headways.
- **Improved Reliability** — Fewer delays and more resilient operations.
- **Enhanced Safety** — Continuous monitoring and automatic protection.
- **Energy Efficiency** — Smoother operations reduce energy use.
- **Better Customer Experience** — More service, less waiting.

CBTC (MOVING BLOCK)

Trains are separated by real-time continuous calculation.

Closer spacing = more trains = more capacity

TRADITIONAL SIGNALING (FIXED BLOCK)

Track is divided into fixed blocks with signals.

More spacing = fewer trains = less capacity

LEGEND

- Onboard (train)
- Wayside (trackside)
- Communication (wireless)
- Central Control (ATS)

Benefits of CBTC Implementation

- Improved reliability and train consistency.
- Reduced delays and wait times.
- Increased train capacity and efficiency.
- Enhanced passenger safety.

Challenges

- High installation and upgrade costs
- Temporary service disruptions during installation
- Complex coordination across subway lines
- Legal, safety, and regulatory requirements
- Long timeline for full system integration

Conclusion

- NYC subway delays are caused by outdated signaling systems
- CBTC provides a modern, data-driven solution
- Improves efficiency, safety, and reliability
- While costly, it is a long-term investment in infrastructure
- Partnership with the MTA allows realistic implementation
- Overall, CBTC can transform the subway into a faster, more dependable system

Thank You