



**American  
Public Transportation  
Association**

# Bryan Sooter

Director of Standards,  
**American Public  
Transportation Association  
(APTA)**



# Passenger Rail: Lay of the Land

PRINCIPLES COURSE



SEATTLE, WA

WRI2025RT



August 26-28,  
2025

# Outline

- Classification of Systems
- Eras of Passenger Rail
- Train Control Systems
- Traction Power Systems
- Railroad Track & Equipment Classifications
- Railroad Shared Corridors
- Passenger Rail Outside North America
- Additional Resources



# *Types of Systems – Streetcar*

- Operate routes on streets in mixed traffic.
- Typically operates with one- or two-car trains powered by overhead catenaries and has frequent stops.



**San Diego MTS Trolley**



# *Types of Systems – Light Rail Transit*

- Operates in mixed traffic or exclusive right-of-way (ROW)
- Train length of 1-4 cars
- Low or high platform
- Primarily overhead power



*LA Metro Rail A-Line*



# *Types of Systems – Light Rail Rapid Transit*

- Fully grade separated with light rail vehicles
- Used on lines with that require high performance but do not have high passenger volumes to justify large stations and long trains
- Examples include:
  - OC Transpo Line 1 (Confederation Line)
  - St. Louis Metro



*SEPTA's Norristown High Speed Line*



*The key thing with the **light metro** is that it's gonna be high speed and it's gonna have a lot of capacity,*  
IBX Project Executive



# *Types of Systems – Heavy Rail*

- Operates in exclusive ROW
- Long trains of six to eight cars or more
- Travel relatively short distances
- Most standardized mode



# *Types of Systems – Commuter/Regional Rail*

- Can be electric, diesel, or alternative fuel propelled
- Operates between a central city & outlying areas at higher average speeds than other rail modes
- Operates on the general railroad network (on both exclusive passenger corridors and on freight owned corridors)



**METROLINK**



**Metra**



**WRI2025RT**

SEATTLE, WA



# *Types of Systems – Intercity & High-Speed Rail*

**Maximum speed on most intercity lines is 79 mph (130 kph)**

**Higher-Speed Rail (HrSR)**

- 80-150 mph (130-250 kph)

**High Speed Rail (HSR)**

- Greater than 150 mph (250 kph)



*NextGen Acela to debut August 28, 2025*



# Classification of Urban Rail Transit Systems

Characteristics	Type \ Mode	Tramway - Streetcar	Light Rail	LRRT	Rapid Transit	Regional Rail
Right-of-way separation	None	■				
	Some		■			
	Grade crossing only		■		■	■
	Full			■	■	■
Max no. of cars/train	1-3	■	■	■		■
	4-10		■	■	■	■
Station platform	Low	■	■			■
	High		■	■	■	■
Power pick-up	Overhead	■	■	■	■	■
	Third rail		■	■	■	■
	(Diesel)		■	■		■
Vehicle travel control	Driver/visual	■	■			
	Permissive signals		■	■	■	■
	Forced stop signals		■	■	■	■
	Automatic		■	■	■	■
Max. vehicle speed	≤ 70 km/h	■				
	71-100 km/h		■	■	■	■
	> 100 km/h		■	■	■	■



# *Passenger Rail Era's – Legacy Systems (pre WWII)*

- 1892 Chicago “L”
- 1897 Boston (tunnels used by streetcars)
- 1904 New York City (trains from Manhattan to the Bronx)
- 1907 Philadelphia Market Street Line
- 1908 Hudson & Manhattan Railroad (PATH)
- 1910 New York Penn Station Opens



**Main Concourse New York Penn Station – 1962**



# *Passenger Rail Era's – Rebirth of Rail Mass Transit*

- 1954 – Toronto TTC Young Line
- 1957 – Cleveland RTA Red Line
- 1972 – Bay Area Rapid Transit
- 1976 – Washington DC Red Line
- 1978 – Edmonton (1<sup>st</sup> modern light rail system in North America)
- 1979 – Atlanta MARTA
- 1983 – Baltimore Subway Link
- 1984 – Miami Metrorail
- 1986 – Vancouver Skytrain
- 1986 – Portland Metropolitan Area Express (MAX)



*Dupont Circle Station Construction*



# *Passenger Rail Era's – Modern Era*

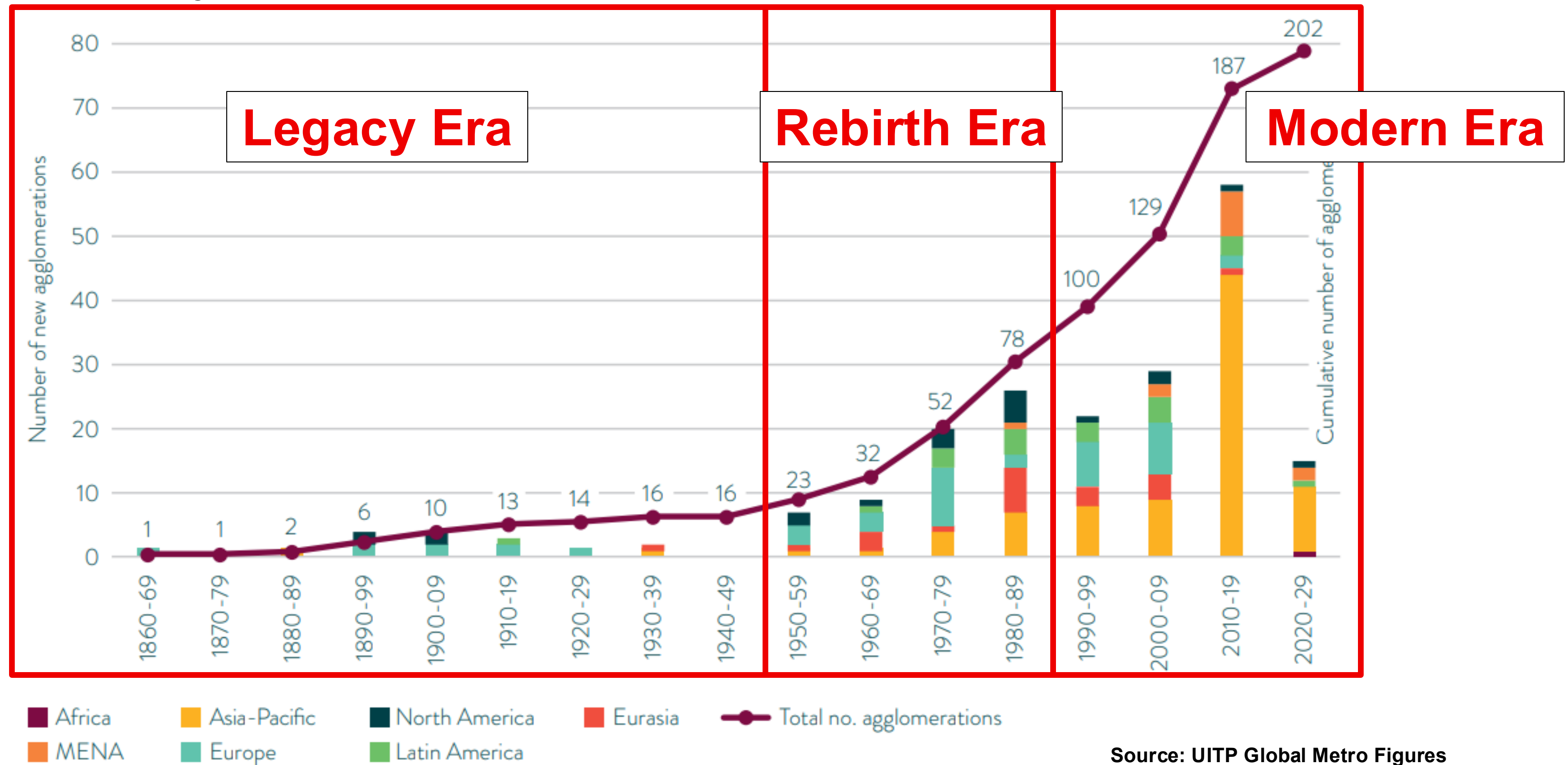
- 1990 – LA Metro Rail
- 1994 – Denver RTD Light Rail
- 1996 – Dallas DART Red & Blue Lines
- 1999 – Utah Transit Light Rail
- 2000 – New Jersey Transit Hudson-Bergen Light Rail
- 2000 – Acela Express (up to 150 mph)
- 2004 – Metro Transit Light Rail (Minneapolis)
- 2009 – Seattle Central Link
- 2019 – TexRail (DFW to Ft. Worth)
- 2023 – Réseau express métropolitain (REM)



***Siemens Amtrak Airo Trainset***



# Number of Cities with Metro Systems by Region



Source: UITP Global Metro Figures 2024 (May 2025)





# *Train Control Systems*

## **General Categories for Train Movement Control**

- **Manual / Visual** – accepted as sufficient for Streetcars
- **Manual / Signals** – manual driving is assisted by automated signals showing occupancy of the track ahead also known as Automatic Train Protection (ATP)
  - Can be permissive or “forced stop”
- **Automatic Train Operation (ATO)** – driver initiates an automatic process and only supervises movement
- **Fully automated** – No personnel require on board for operation

Fixed block and track circuits are the historical method for ATP

Transit systems are moving towards communications-based train control (CBTC) which features:

- Moving block
- Higher level of service
- Increased reliability

Railroads use Positive Train Control (PTC) which is an overlay of an existing train control system used to enforce speed and signal compliance.

# Traction Power

**Diesel-Electric**– Used by primarily by commuter and intercity passenger railroads with ac traction motors

- Pros: Range, versatile
- Cons: slow acceleration, emission requirements

**Alternative Fuel Source (hydrogen fuel cell or battery electric) -**

- Pros: Zero Emissions
- Cons: New technology, limited applications, fuel/power availability



*Metra SD70MAC*



*Stadler FLIRT ZEMU*



# *Traction Power*

**Overhead Catenary** – Most proven and widely used system for electrified intercity rail, light rail, and high-speed railways. Voltages range up to 25 kV ac

- Pros: reduced cost of power supply equipment and improving efficiency, increased safety at track level
- Cons: Need for regular catenary maintenance and challenges from urban environments. Increased cost to tunnel construction

**Third Rail** - Primarily used on heavy rail systems at 750 V dc

- Pros: No electromagnetic interference issues, reduced maintenance
- Cons: Speed limited to ~100 mph, track maintenance, power gaps





# Railroad Track Classifications

	The maximum allowable operating speed for <b>freight trains</b> is—	The maximum allowable operating speed for <b>passenger trains</b> is—
Excepted track	10	N/A
Class 1 track	10	15
Class 2 track	25	30
Class 3 track	40	60
Class 4 track	60	80
Class 5 track	80	90
Over track that meets all of the requirements prescribed in this subpart for—	The maximum allowable operating speed <b>for trains</b> is <sup>1</sup>	
Class 6 track	110 m.p.h.	
Class 7 track	125 m.p.h.	
Class 8 track	160 m.p.h. <sup>2</sup>	
Class 9 track	220 m.p.h. <sup>2</sup>	
Grade crossing at Class 7 require FRA approval. No at-grade (level) crossings on Class 8 and 9 track		

# Passenger Railroad Equipment Classifications



## Tier I (conventional):

- Maximum Speed = 125 mph (~200 kph)
- Traditional "FRA Compliant" Equipment (49 CFR §229 & 238)



## Tier II (Northeast Corridor):

- Maximum speed = 160 mph (~260 kph)



## Tier III (High Speed Rail)

- Maximum Speed = 220 mph (355 kph)
- Interoperable with all tiers up to 125 mph

**Note:** The FRA regulations that make up Tier III requirements was broken up into two rules informally known as NPRM 1 and NPRM 2.

Final Rule for NPRM 1 Published on November 21, 2018.

- Trainset  
Structure/Crashworthiness
- Interior Attachments
- Glazing
- Brake System

No final rule for NPRM 2. (The NPRM was published on April 3, 2023)

- Inspection Testing & Maintenance
- Compliance Testing & Startup
- General Safety
- Safety Appliances

# Challenges of Railroad Shared Use Corridors

***Passenger and freight trains are like oil and water; they don't mix well!***

## **Safety**

- Risk mitigation
- Operating practices
- Safety technology
- Highway/rail grade crossings

## **Infrastructure and Rolling Stock**

- Wheel-load characteristics
- Track structure and components
- Special trackwork
- Track geometry
- Vehicle-track interaction (VTI)
- Stations
- Signaling systems and train control technology

## **Planning and Operation**

- Planning process
- Host railroad negotiation
- Train scheduling
- Capacity planning
- Train control and operations

## **Economic**

- Capital cost sharing
- Passenger operation sustainability
- Freight level of service preservation

## **Institutional**

- Regulatory compliance
- Performance incentives/penalties
- Grant agreement structure
- Liability



# *Passenger Rail Service Elsewhere in the World*

- Passenger service has often been the principal, or at least the most important, type of service provided by railroads, especially in Europe, India, China, Japan and elsewhere
- Freight transport secondary
- In contrast to North America, these railroads were often owned and operated by governments, not private sector
- Not as subject to market-place pressure for efficiencies
- Very large capital investment in infrastructure and equipment, subsidization of operating expense, extensive civil service employment



# *Additional Resources*

## **Federally Sponsored Research Reports**

### Transport Canada

- <https://tc.canada.ca/en/rail-transportation/publications>

### Federal Transit Administration

- <https://www.transit.dot.gov/research-innovation/fta-reports-and-publications>

### Federal Railroad Administration

- <https://railroads.dot.gov/research-development/program-areas/human-factors/ctil/reports-presentations>



<https://www.apta.com/research-technical-resources/standards/>



<https://www.arena.org/>



<https://www.trb.org/TCRP/TCRP.aspx>

