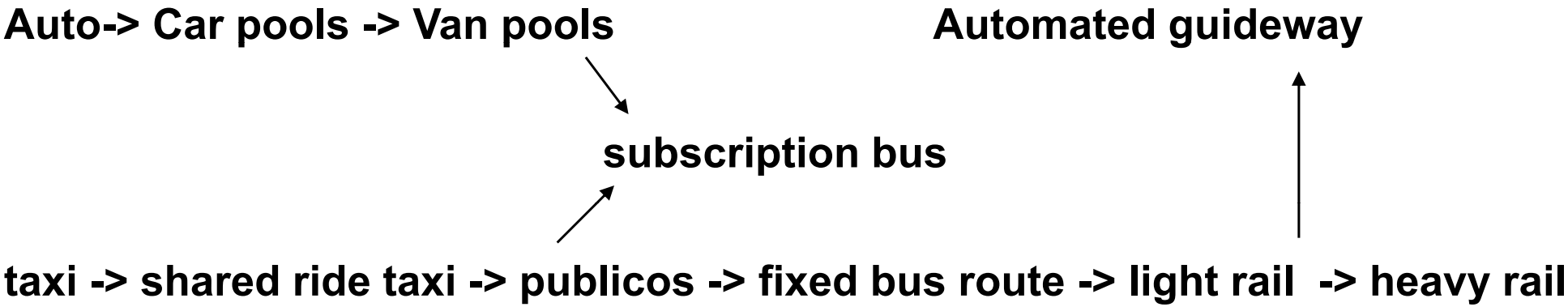
# PUBLIC TRANSPORT MODAL CHARACTERISTICS AND ROLES

## Outline

1. Range of Modes and Services
2. Modal Descriptions
3. Modal Comparisons and Performance Characteristics

# Roles for Each Mode

**Low density flows --------> High density flows**
**Spread O-D flows --------> Concentrated O-D flows**



# Spectrum of Services

**Increasing vehicle capacity ----->**
**Increasing passenger flows ----->**

| Vehicle Type / Operating Arrangements | Car | Van | Minibus | Bus | Light Rail | Heavy Rail |
|---|---|---|---|---|---|---|
| Drivers | Free | | Low Cost | | High Cost (conventional transit) | Low Cost (automated) |
| Right of way | Shared | | | | Dual Mode | Dedicated |
| Routing and Scheduling | Flexible | | Hybrid | | Fixed | |

# Transit Categories (based on Vuchic)

1. **Rights of Way**

   **Based on degree of segregation**

   - **Surface with mixed traffic: buses, light rail: with/without preferential treatment**
   - **Longitudinal separation but at-grade crossing interference: light rail, bus rapid transit**
   - **Full separation: at-grade, tunnel, elevated**

# Transit Categories (cont'd)

## 2. Technologies

Key technological characteristics:

(a) Support - contact between vehicle and surface

- rubber tire on concrete
- steel wheel on steel rail
- others

(b) Guidance - lateral control:

- steered by driver
- guided by track
- others

# Transit Categories (cont'd)

## 2. Technologies (cont'd)

### (c) Propulsion:

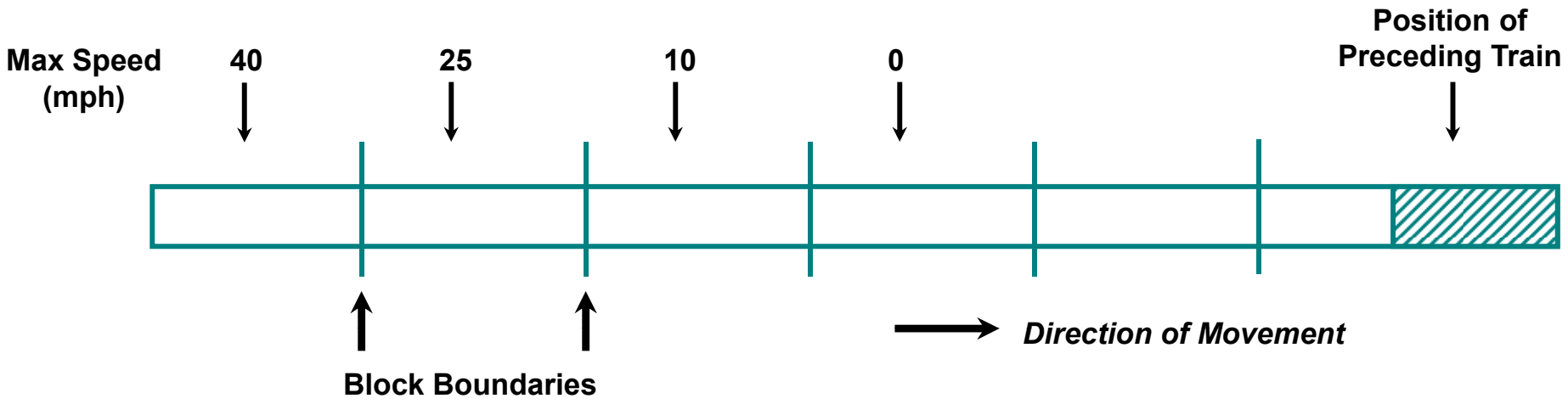
- diesel ICE: conventional or clean
- CNG
- electric motor
- hybrid
- others

### (d) Control

- manual/visual
- manual/signal
- automatic: ATO, ATC

# Basics of Train Control

- Tracks are divided into fixed "blocks" (track circuits), ranging from hundreds to thousands of meters in length
- Max speed in a block is based on track geometry and the location of the preceding train




- Block design is critical to service quality and capacity

# Example

## MBTA Red Line southbound


- train cannot enter Park St until the preceding train has departed Downtown Crossing
- minimum headway is:

  *Close-in Time + Dwell time at Park + Running time Park⇒Downtown Crossing + Dwell time at Downtown Crossing + Exit time*

  -- approximately 3 minutes

# Levels of Automated Protection

- None (MBTA Green Line): advisory wayside signals
- Manual setting of speed below the maximum level plus dwell times (MBTA Red Line): in-cab signals
- Manual setting of dwell time only (WMATA)
- Automatic Train Supervision/Regulation: Tren Urbano, LUL Central Line
- Full automation LUL Jubilee Line-London, RER-Paris
- Capacity increased through moving block or Communication-Based Train Control (NYCT Canarsie Line)

# Modal Descriptions

**Bus: vehicles operating individually with rubber tires, with manual lateral and longitudinal control**

**Key decisions:**

**Vehicle size:** minibus (20 passengers) up to bi-articulated (165+ passengers)

**Vehicle design:** high floor or low floor

**Right-of-way:** all options are available

**Guidance:** is guided operation appropriate at some locations?

**Propulsion:** all options available

**Fare payment:** on-vehicle or off-vehicle

# Modal Descriptions (cont'd)

**Light Rail: vehicles operating individually or in short trains with electric motors and overhead power collector, steel wheel on steel rail with manual or automatic longitudinal control**

**Key decisions:**

- **Vehicle design: high floor or low floor, articulated or rigid body**
- **Right-of-way: all options available**
- **Operating arrangements: automated or manually driven**

# Modal Descriptions (cont'd)

**Heavy Rail/Metro: vehicles operating in trains with electric motors on fully separated rights-of-way with manual signal or automatic longitudinal control; level boarding, off-vehicle fare payment**

**Key decisions:**

- **Train length**
- **Right-of-way: at-grade, elevated, or tunnel**
- **Station spacing**
- **Operating arrangements: degree of automation**

# Modal Descriptions (cont'd)

**Commuter Rail: vehicles operating in trains with long station spacing, serving long trips into central city, large imbalance between peak hour and other period ridership.**

**Key decisions:**

- **Fare collection strategies**
- **Line length**
- **Through routing in CBD**
- **Station spacing**
- **Extent of parking$_{ca}$ pacity**

## Traditional Transit Services

- Bus on shared right-of-way
- Streetcar on shared right-of-way
- Heavy rail on exclusive right-of-way
- Commuter/Regional rail on semi-exclusive right-of-way

## Newer Service Concepts

- Bus Rapid Transit (including exclusive lanes and/or TSP)
- Light Rail on exclusive right-of-way

# Increasing Diversity

- Driver arrangements: part-timers, 10-hour days, pay by vehicle type
- Routing and scheduling: fixed, flexible, advance booking
- Vehicle types: minibuses, articulated buses and railcars, bi-level railcars, low-floor
- Control options: fixed block, moving block, manual, ATO, ATC
- Priority options: full grade separation, semi-exclusive right-of-way, signal pre-emption
- Dual mode operations: bus, light rail

# Modal Comparison: Bus vs. Rail

**Rail advantages:**

- High capacity
- Lower operating costs
- Better service quality
- Stronger land use influence
- Fewer negative externalitities

**Bus advantages:**

- Low capital costs
- Wide network coverage
- Single vehicle trips
- Flexibility
- "Dual mode" nature

# 2007 US Transit Mode Performance Measures

| | Bus | Heavy Rail | Light Rail | Commuter Rail | Paratransit |
|---|---|---|---|---|---|
| Operating Expenses ($ millions) | 17,308 | 5,888 | 1,170 | 4,015 | 4,421 |
| Annual Unlinked Passenger Trips (millions) | 5,412 | 3,460 | 419 | 459 | 209 |
| Annual Passenger Miles (millions) | 20,978 | 16,138 | 1,932 | 10361 | 1,502 |
| Annual Revenue Vehicle Miles (RVM) | 1987 | 638.5 | 82.7 | 297.4 | 1,274 |
| Annual Revenue Vehicle Hours (RVH) | 158 | 31.8 | 5.5 | 9.5 | 105.2 |
| Op. Cost/RVH ($) | 110 | 185.15 | 212.72 | 422.63 | 42.0 |
| Op. Cost/RVM ($) | 8.7 | 9.22 | 14.14 | 13.5 | 3.47 |
| Op. Cost/Unlinked Pass Trip ($) | 3.2 | 1.7 | 4.22 | 8.75 | 21.15 |
| Op. Cost/Pass Mile ($) | .83 | .36 | .61 | 0.39 | 2.94 |
| Unl. Pass Trips/ RVH (millions) | 34.3 | 108.8 | 76.18 | 48.3 | 1.99 |
| Pass Miles/RVH | 132.8 | 507.48 | 351.27 | 1,090.63 | 14.27 |
| Mean Trip Length (miles) | 3.9 | 4.7 | 4.6 | 24.3 | 7.2 |
| Mean Pass Load | 10.6 | 25.3 | 23.4 | 37.5 | 1.2 |
| Mean Operating Speed (mph) | 12.6 | 20.1 | 15.1 | 31.4 | 12.1 |

# Ridership Trends by Mode

| Mode | | 2007 Ridership (Millions) | Ridership Change 1970-2007 | Percent Change 1970-2007 |
|---|---|---|---|---|
| Heavy Rail | 5 old systems | 2908 | 1227 | +65% |
| | 7 new systems | 552 | | |
| Light Rail | 7 old systems | 179 | -56 | -24% |
| | 23 new systems | 240 | | |
| Commuter Rail | 4 old systems | 409 | 129 | +46% |
| | 16 new systems | 50 | | |
| Bus | | 5,413 | 378 | +8% |
| Total - all modes* | | 9,750 | 2,320 | ≈ +40% |

** includes other modes such as paratransit and trolleybus*

**"Old" systems began pre-1970; "New" systems began post-1970**

# Changes in Service Provided (1997-2007) by Mode

| | Active Vehicles | Revenue Vehicle Miles Operated |
|---|---|---|
| Heavy Rail | +10% | +18% |
| Light Rail | +68% | +105% |
| Commuter Rail | +18% | +30% |
| Bus | +14%[1] | +7% |

[1] Series changed in 2007. For bus, change is 1997-2006

# Service Utilization Trends by Mode

| Boardings/Vehicle Mile | | | Passenger Load | | |
|---|---|---|---|---|---|
| Mode | 2007 | % change 1997-2007 | Mode | 2007 | % change 1997-2007 |
| Heavy Rail | 5.4 | +20% | Heavy Rail | 25.3 | +13% |
| Light Rail | 5.1 | -22% | Light Rail | 23.4 | -15% |
| Commuter Rail | 1.5 | -1% | Commuter Rail | 37.5 | +7% |
| Bus | 2.7 | +10% | Bus | 10.6 | +9% |

1.258J / 11.541J / ESD.226J Public Transportation Systems

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