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

Auto-> Car pools -> Van pools

Automated guideway

subscription bus

taxi -> shared ride taxi -> publicos -> fixed bus route -> light rail -> heavy rail
## Spectrum of Services

Increasing vehicle capacity ⬥ Increasing passenger flows ⬥

<table>
<thead>
<tr>
<th>Operating Arrangements</th>
<th>Car</th>
<th>Van</th>
<th>Minibus</th>
<th>Bus</th>
<th>Light Rail</th>
<th>Heavy Rail</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vehicle Type</strong></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td><strong>Operating Arrangements</strong></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Drivers</strong></td>
<td>Free</td>
<td></td>
<td>Low Cost</td>
<td></td>
<td>High Cost</td>
<td>Low Cost</td>
</tr>
<tr>
<td>(conventional transit)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(automated)</td>
</tr>
<tr>
<td><strong>Right of way</strong></td>
<td></td>
<td>Shared</td>
<td></td>
<td></td>
<td>Dual Mode</td>
<td>Dedicated</td>
</tr>
<tr>
<td><strong>Routing and Scheduling</strong></td>
<td>Flexible</td>
<td>Hybrid</td>
<td></td>
<td></td>
<td>Fixed</td>
<td></td>
</tr>
</tbody>
</table>

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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
2. Technologies

Key technical 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
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
• 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:

  \[ \text{Close-in Time} + \text{Dwell time at Park} + \text{Running time Park} \rightarrow \text{Downtown Crossing} \\
  + \text{Dwell time at Downtown Crossing} + \text{Exit time} \]

  -- 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
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 capacity
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 externalities

Bus advantages:
- Low capital costs
- Wide network coverage
- Single vehicle trips
- Flexibility
- “Dual mode” nature
## 2007 US Transit Mode Performance Measures

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

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Heavy Rail</td>
<td>5 old systems 7 new systems</td>
<td>2908 552</td>
<td>1227</td>
</tr>
<tr>
<td>Light Rail</td>
<td>7 old systems 23 new systems</td>
<td>179 240</td>
<td>-56</td>
</tr>
<tr>
<td>Commuter Rail</td>
<td>4 old systems 16 new systems</td>
<td>409 50</td>
<td>129</td>
</tr>
<tr>
<td>Bus</td>
<td></td>
<td>5,413 378</td>
<td></td>
</tr>
<tr>
<td>Total - all modes*</td>
<td></td>
<td>9,750 2,320</td>
<td></td>
</tr>
</tbody>
</table>

* includes other modes such as paratransit and trolleybus

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

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

<table>
<thead>
<tr>
<th>Mode</th>
<th>Active Vehicles</th>
<th>Revenue Vehicle Miles Operated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heavy Rail</td>
<td>+10%</td>
<td>+18%</td>
</tr>
<tr>
<td>Light Rail</td>
<td>+68%</td>
<td>+105%</td>
</tr>
<tr>
<td>Commuter Rail</td>
<td>+18%</td>
<td>+30%</td>
</tr>
<tr>
<td>Bus</td>
<td>+14%(^1)</td>
<td>+7%</td>
</tr>
</tbody>
</table>

\(^1\) Series changed in 2007. For bus, change is 1997-2006
## Service Utilization Trends by Mode

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Heavy Rail</td>
<td>5.4</td>
<td>+20%</td>
<td>Heavy Rail</td>
<td>25.3</td>
</tr>
<tr>
<td>Light Rail</td>
<td>5.1</td>
<td>-22%</td>
<td>Light Rail</td>
<td>23.4</td>
</tr>
<tr>
<td>Commuter Rail</td>
<td>1.5</td>
<td>-1%</td>
<td>Commuter Rail</td>
<td>37.5</td>
</tr>
<tr>
<td>Bus</td>
<td>2.7</td>
<td>+10%</td>
<td>Bus</td>
<td>10.6</td>
</tr>
</tbody>
</table>

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