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

<table>
<thead>
<tr>
<th>Low density flows</th>
<th>High density flows</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spread OD flows</td>
<td>Concentrated OD flows</td>
</tr>
<tr>
<td>Low vehicle capacity</td>
<td>High vehicle capacity</td>
</tr>
</tbody>
</table>

Auto → Car Pool → Van Pool
Subscription Bus

Taxi → Shared Taxi → Públicos → Fixed Route Bus → BRT → Light Rail → Heavy Rail

Spectrum of Services

Transit Categories

Increasing vehicle capacity & passenger flows

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

1. Rights of Way - degree of segregation
   a. surface with mixed traffic
      - buses and light rail with or without preferential treatment
   b. longitudinal separation but at-grade crossing interference
      - light rail and bus rapid transit
   c. full separation
      - at-grade, tunnel, elevated
Transit Categories

2. Technologies
   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
   c. Energy and Propulsion
      - diesel internal combustion engine (conventional or clean)
      - compressed natural gas
      - electric motor
      - hybrid
      - others
   d. Control - longitudinal
      - manual/visual
      - manual/signal
      - automatic

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

Train Signal Blocking Example: MBTA Red Line Southbound

- A train may not enter Park St until the train ahead Departs Downtown Crossing.
- Minimum headway is the sum of
  - close-in time
  - dwell time at Park St
  - running time between Park St and Downtown Crossing
  - dwell time at Downtown Crossing
  - exit time
- Approximately 3 minutes

Levels of Automated Protection

1. None (MBTA Green Line): advisory wayside signals
2. Manual setting of speed below the maximum level plus dwell times (MBTA Red Line): in-cab signals
3. Manual setting of dwell time only (WMATA)
4. Automatic Train Supervision/Regulation: Tren Urbano, LUL Central Line
6. 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 (10-20 passengers) up to bi-articulated (165-250 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: 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: Heavy Rail

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: 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
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

Traditional and New Service Concepts

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

Modal Comparison: Bus vs. Rail

Rail Advantages
- High capacity
- Lower unit 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
### US Transit Mode Performance Measures

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<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Bus</td>
<td>18,704.0</td>
<td>6,310.5</td>
<td>1,409.9</td>
<td>4,625.7</td>
<td>4,966.5</td>
<td>116.7</td>
<td>192.4</td>
<td>239.0</td>
<td>453.5</td>
<td>53.9</td>
<td>134.0</td>
<td>3.9</td>
<td>10.7</td>
<td>12.5</td>
</tr>
<tr>
<td>Heavy Rail</td>
<td>5,452.0</td>
<td>3,490.0</td>
<td>465.0</td>
<td>112.4</td>
<td>140.0</td>
<td>9.3</td>
<td>9.5</td>
<td>15.8</td>
<td>14.6</td>
<td>3.8</td>
<td>203.3</td>
<td>4.8</td>
<td>25.2</td>
<td>20.3</td>
</tr>
<tr>
<td>Light Rail</td>
<td>2,011.3</td>
<td>666.8</td>
<td>89.3</td>
<td>317.9</td>
<td>319.2</td>
<td>3.4</td>
<td>1.8</td>
<td>3.0</td>
<td>9.9</td>
<td>26.1</td>
<td>106.4</td>
<td>4.7</td>
<td>24.6</td>
<td>15.1</td>
</tr>
<tr>
<td>Commuter Rail</td>
<td>160.3</td>
<td>32.8</td>
<td>5.9</td>
<td>10.2</td>
<td>9.1</td>
<td>0.9</td>
<td>0.4</td>
<td>0.6</td>
<td>0.4</td>
<td>3.4</td>
<td>78.8</td>
<td>24.0</td>
<td>35.3</td>
<td>31.2</td>
</tr>
<tr>
<td>Paratransit</td>
<td></td>
<td></td>
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### Ridership Trends by Mode

<table>
<thead>
<tr>
<th>Mode</th>
<th>2009 Ridership (Millions)</th>
<th>% Change (1974-2009)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heavy Rail</td>
<td>5 old systems</td>
<td>2,812</td>
</tr>
<tr>
<td></td>
<td>7 new systems</td>
<td>678</td>
</tr>
<tr>
<td>Light Rail</td>
<td>7 old systems</td>
<td>188</td>
</tr>
<tr>
<td></td>
<td>16 new systems</td>
<td>276</td>
</tr>
<tr>
<td>Commuter Rail</td>
<td>4 old systems</td>
<td>325</td>
</tr>
<tr>
<td></td>
<td>12 new systems</td>
<td>139</td>
</tr>
<tr>
<td>Bus</td>
<td></td>
<td>5,452</td>
</tr>
<tr>
<td>Total - all modes*</td>
<td></td>
<td>10,381</td>
</tr>
</tbody>
</table>

* "Old" systems began pre-1970, "New" systems began post-1970
* includes other modes such as paratransit and trolleybus

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### Changes in Service Provided by Mode (1999-2009)

<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>+19%</td>
</tr>
<tr>
<td>Light Rail</td>
<td>+43%</td>
<td>+87%</td>
</tr>
<tr>
<td>Commuter Rail</td>
<td>+20%</td>
<td>+31%</td>
</tr>
<tr>
<td>Bus¹</td>
<td>+11%</td>
<td>+9%</td>
</tr>
</tbody>
</table>

¹ NTD changed methodology for 2007, so there is a discontinuity. Bus figures are for 1999-2006.

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### Service Utilization Trends by Mode

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</tr>
</thead>
<tbody>
<tr>
<td>Boardings/Revenue Vehicle Mile</td>
<td></td>
<td></td>
<td>Passenger Load</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heavy Rail</td>
<td>5.2</td>
<td>+14%</td>
<td>Heavy Rail</td>
<td>25.2</td>
<td>+10%</td>
</tr>
<tr>
<td>Light Rail</td>
<td>5.2</td>
<td>-15%</td>
<td>Light Rail</td>
<td>24.6</td>
<td>-2%</td>
</tr>
<tr>
<td>Commuter Rail</td>
<td>1.5</td>
<td>-10%</td>
<td>Commuter Rail</td>
<td>35.3</td>
<td>-2%</td>
</tr>
<tr>
<td>Bus</td>
<td>2.7</td>
<td>-5%</td>
<td>Bus</td>
<td>10.7</td>
<td>-1%</td>
</tr>
</tbody>
</table>

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