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

Spread OD flows

Low vehicle capacity

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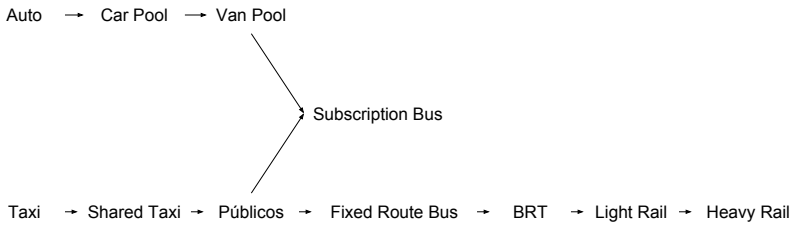
High density flows

Concentrated OD flows

High vehicle capacity



Spectrum of Services

Increasing vehicle capacity & passenger flows

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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

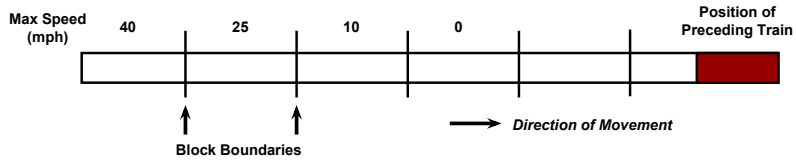
1. Rights of Way - degree of segregation
   a. surface with mixed traffic
      - buses and light rail with or without preferential treatment
   b. longitudinal separation but at-grade crossing interference
      - light rail and bus rapid transit
   c. full separation
      - at-grade, tunnel, elevated

Transit Categories

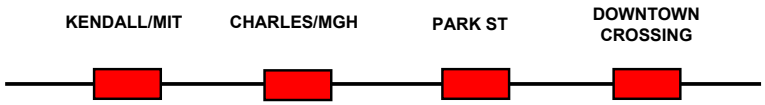
2. Technologies
   a. Support - contact between vehicle and surface
      - rubber tire on concrete
      - steel wheel on steel rail
      - others
   b. Guidance - lateral control
      - steered by driver
      - guided by track
      - others
   c. Energy and Propulsion
      - diesel internal combustion 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
5. Full automation: LUL Jubilee Line-London, Line 14-RATP, Paris
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

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CURITIBA
cidade de curitiba
HE702

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SERVICE GRATUIT
1 bus toutes les 6 min
7H30-19H30
du lundi au samedi
le huit

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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

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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

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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

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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

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 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

	Bus	Heavy Rail	Light Rail	Commuter Rail	Paratransit
Operating Expenses ($ millions)	18,704.0	6,310.5	1,409.9	4,625.7	4,966.5
Annual Unlinked Passenger Trips (millions)	5,452.0	3,490.0	465.0	468.0	190.0
Annual Passenger Miles (millions)	21,477.0	16,805.0	2,199.0	11,232.0	1,477.0
Annual Revenue Vehicle Miles (RVM)	2,011.3	666.8	89.3	317.9	1,319.3
Annual Revenue Vehicle Hours (RVH)	160.3	32.8	5.9	10.2	92.1
Op. Cost/RVH ($)	116.7	192.4	239.0	453.5	53.9
Op. Cost/RVM ($)	9.3	9.5	15.8	14.6	3.8
Op. Cost/Unlinked Pass Trip ($)	3.4	1.8	3.0	9.9	26.1
Op. Cost/Pass Mile ($)	0.9	0.4	0.6	0.4	3.4
Unl. Pass Trips/ RVH (millions)	34.0	106.4	78.8	45.9	2.1
Pass Miles/RVH	134.0	512.3	372.7	1101.2	16.0
Mean Trip Length (miles)	3.9	4.8	4.7	24.0	7.8
Mean Pass Load	10.7	25.2	24.6	35.3	1.1
Mean Operating Speed (mph)	12.5	20.3	15.1	31.2	14.3

Source: APTA Fact Book 2011 (for 2009)

Ridership Trends by Mode

Mode		2009 Ridership (Millions)	% Change (1974-2009)
Heavy Rail	5 old systems	2,812	(old only) +63%
	7 new systems	678	
Light Rail	7 old systems	188	(old only) +26%
	16 new systems	276	
Commuter Rail	4 old systems	325	(old only) +36%
	12 new systems	139	
Bus		5,452	+10%
Total - all modes*		10,381	+45%

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

* includes other modes such as paratransit and trolleybus

Source: APTA Fact Book 2011

Changes in Service Provided by Mode (1999-2009)

	Active Vehicles	Revenue Vehicle Miles Operated
Heavy Rail	+10%	+19%
Light Rail	+43%	+87%
Commuter Rail	+20%	+31%
Bus[1]	+11%	+9%

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

Source: APTA Fact Book 2011

Service Utilization Trends by Mode

Boardings/Revenue Vehicle Mile			Passenger Load		
Mode	2009	% change 1999-2009	Mode	2009	% change 1999-2009
Heavy Rail	5.2	+16%	Heavy Rail	25.2	+10%
Light Rail	5.2	-15%	Light Rail	24.6	-2%
Commuter Rail	1.5	-10%	Commuter Rail	35.3	-2%
Bus	2.7	-5%	Bus	10.7	-1%

Source: APTA Fact Book 2011

1.258J / 11.541J Public Transportation Systems
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