PUBLIC TRANSPORT MODAL CHARACTERISTICS AND ROLES

Outline

1. Range of Modes and Services
2. Modal Descriptions
3. Modal Comparisons and Performance Characteristics
4. Simple Capacity Analysis

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 ----->

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. <u>Rights of Way</u>

   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

Key technological characteristics:

(c) Propulsion:

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

(d) Control

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

Modal Descriptions

<u>Bus</u>: vehicles operating individually with rubber tires, with manual lateral and longitudinal control

<u>Key decisions</u>:

Vehicles 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.

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

New/Recent Service Concepts

- Bus Rapid Transit
- 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 externalitites

Bus advantages:

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

2001 US Transit Mode Performance Measures

	Bus	Heavy Rail	Light Rail	Commuter Rail	Paratransit
Unlinked Passenger Trips (x 10^9)	5.8	2.7	0.3	0.4	0.1
Annual Pass-miles (x 10^9)	22.0	14.2	1.4	9.6	0.8
Op. Cost/ Rev Veh Hr ($)	82.80	144.42	192.55	356.51	37.86
Op. Cost/Rev Veh Mile ($)	6.48	7.07	12.75	11.31	2.62
Op. Cost/Unlinked Pass Trip ($)	2.28	1.53	2.03	6.83	16.70
Op. Cost/Pass. Mile ($)	0.61	0.29	0.47	0.30	2.05
Unl. Pass Trips/ Rev Veh Hr	36.3	94.3	94.9	52.2	2.27
Pass Miles/Rev Veh Hr	137	490	406	1,190	18
Mean Trip Length (miles)	3.8	5.2	4.3	22.8	8.1
Mean Pass Load	10.7	24.0	26.9	37.7	1.3
Mean Operating Speed (mph)	12.8	20.4	15.1	31.5	14.6

Ridership Trends by Mode

Mode		2000 Ridership (Millions)	Change 1975-2000 (%)
Metro	- 5 old systems - 6 new systems	2,184 447	560 (+28%)
Light Rail	- 7 old systems - 11 new	161 153	37 (+30%)
Commuter Rail	- 4 old systems - 7 new systems	383 28	130 (+52%)
Bus		5,678	-26 (-1%)
Total		9,034	1,312 (+18%)

Changes in Service Provided (1990-2000) by Mode

	Active Vehicles	Vehicle Miles Operated
Metro	+2%	+11%
Light Rail	+73%	+118%
Commuter Rail	+15%	+27%
Bus	+28%	+9%

Service Utilization Trends by Mode

	Boardings/Vehicle Mile		Avg. Passenger Load	
Mode	2000		2000	
Metro	4.4	-1%	23	---
Light Rail	6.1	-16%	26	+9%
Commuter Rail	1.5	-1%	35	+4%
Bus	2.5	-8%	9	-7%

Simple Capacity Analysis

Question: Given a pie-shaped sector corridor serving a CBD served by a single transit line, what will be the peak passenger flow at the CBD?

Simple Capacity Analysis

Given: P_c = population density at CBD
dP = rate of decrease of population density with distance from CBD
θ = angle served by corridor
r = distance out from CBD
L = corridor length
t = number of one-way trips per person per day
c = share of trips inbound to CB
m = transit market share for CBD-bound trips
p = share of CBD-bound transit trips in peak hour

Then:
Population in corridor = $\int_0^L r\theta(P_c - dPr)dr$

$$= L^2\theta\left(\frac{P_c}{2} - \frac{dPL}{3}\right)$$

Simple Capacity Analysis

Peak Passenger Flow = $L^2\theta\left(\frac{P_c}{2} - \frac{dPL}{3}\right)tcmp$

Maximum access distance to transit line = $L❑/2$

Examples:

P_c	dP	❑	L	t	c	m	p	Req. Capacity	Max Access
10,000	800	2Π /9	10	2.5	0.2	0.5	0.25	10,000	3.5
20,000	1,600	2Π /9	10	1.5	0.3	0.8	0.25	30,000	3.5