Personal Rapid Transit Capacity

The burgeoning interest in personal rapid transit (PRT) in India is highlighting the issue of PRT capacity. This is a fairly complex topic that will be dealt with fairly briefly here. Note: network capacity is much more complex than just the guideway capacity that is dealt with here. PRT capacity is complex because it is impacted by a number of issues:

Brick wall stopping (BWS) criteria. This is a railroad safety criterion that many believe not to be applicable to PRT. Basically BWS requires that a train must be able to stop before hitting a preceding train if that preceding train instantaneously turns into a stationary brick wall. In order to meet BWS the time between trains (or T-Pods in the case of PRT) must be adjusted based on speed and the maximum available, or allowable, deceleration.

Deceleration. The maximum deceleration is a function of the available friction and of whether passengers are standing or sitting, wearing seat belts, etc. The available friction or deceleration force varies with the type of PRT system. PRT systems driven and decelerated by linear induction motors rely on their motors for their primary breaking force and are typically independent of friction and thus weather. The maximum breaking deceleration they apply is typically less than what is available. Rubber-tired PRT systems, on the other hand, are dependent on the friction between their tires and the riding surface which can be dramatically impacted by weather. These systems will usually have weather mitigation plans aimed at maintaining friction above about 0.25G where G is the force of gravity.

Minimum headway. This is the minimum time between vehicles measured from the front of one vehicle to the front of the other. For BWS criteria, it varies from about 1.4 seconds with 0.50G deceleration force at 15 mph to about 3.2 seconds with 0.25G deceleration force at 30 mph. Without BWS criteria many suppliers claim they will achieve minimum headways of 0.5 seconds. Cabintaxi demonstrated 0.5 second PRT headways but never proved endurance or safety at these headways. We therefore believe it prudent to plan for minimum headways of no less than 1.0 seconds. Headway is strongly tied to capacity since reducing headway by half theoretically doubles capacity.

Occupancy. This is the number of passengers per T-pod. Occupancy is also strongly tied to capacity since doubling the occupancy theoretically doubles capacity. However increasing PRT occupancy during peak hours usually involves ride sharing. This can be easily accomplished on small systems with few stations but is difficult to accomplish on large systems with many stations. Imagine how long a passenger bound to station 57 in a 100 station system would have to wait for another to arrive also bound for station 57. Ride sharing protocols to overcome this problem will be the subject of a future article.

The table below provides the theoretical guideway capacity in passengers per hour based on variations in the parameters discussed above. The reasonable capacity of PRT guideways is seen to range between about 1,000 and 14,000 passengers per hour. Since PRT systems tend to cost much less than other fixed guideway systems, it is usually useful to compare the costs required to meet the capacity demand.

Maximum Theoretical Personal Rapid Transit Capacities

	With Brick Wall Stopping (BWS)[1]								Without BWS			
Speed	15 mph (24 kph)				30 mph (48 kph)				Unlimited		Unlimited	
Deceleration (g)[2]	0.25		0.50		0.25		0.50		0.50	0.50	0.50	0.50
Minimum Headway (sec)	2.0	2.0	1.4	1.4	3.2	3.2	1.7	1.7	1.0	1.0	0.5[3]	0.5
Occupancy (passengers)	1	4	1	4	1	4	1	4	1	4	1	4
Passengers per Hour	1,800	7,200	2,571	10,285	1,125[4]	4,500	2,117	8,470	3,600	14,400[5]	7,200	28,800

[1] Brick Wall Stopping is a railroad safety criterion many consider not applicable to PRT

[2] 0.50G deceleration is similar to max breaking by a car on a wet road and is not obtainable with rubber tires on an icy surface

[3] Cabintaxi demonstrated 0.5 second PRT headways but never proved endurance or safety at these headways.

[4] Reasonable practical minimum capacity ~ 1,000 passengers per hour per direction

[5] Reasonable practical maximum capacity ~ 14,000 passengers per hour per direction