Version 16.04.2021

#Schwebebahn, # tram, # light rail # subway, # local train, # route extension
Extension of the route, # reactivation of the route, # closure of the route, # land degradation, # ecological footprint, # traffic turnaround

Aspects for Operation of

Digital Operated Suspended Railways

- first summary -

Kabinen/ Module/ Pods

Stationen/ stations

Strecken/ tracks

Impressum

SMT (Smart Mass Transit) and PRT (Personal Rapid Transit) can revolutionize public transport.
This elaboration offers an approach to the topic.
Siegfried Wohlfahrt

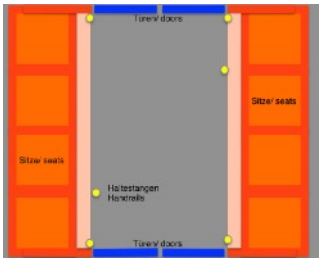
Modules / pods / vehicles

Conditions:

- **Barrier-free:** Driving, getting on and off should always be easy and safe, even if wheelchair, walker, stroller and luggage are included.
- **Comfort:** As many seats as possible for a high level of comfort.
- **Pay attention to mobility demands / wishes / needs:**
  Enough space for personal things, shopping, luggage, beach luggage, etc.
  Enough space for a family outing, for example (1 parent +1 child + 2 bicycles).
  There is also enough space so that the passengers do not feel cramped. A trip, even with (foreign) fellow travelers, is more pleasant.
- **cleanliness**
- **Robust and low-maintenance** design (... because the number of pods is very large).

These requirements are met by the module / pod „Standard“

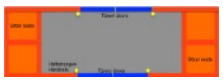
Width: 200 cm
Length: approx. 250 cm
Capacity: 16 passengers
8 seats, 8 standing places, or 2 bicycles etc., = 16 passengers



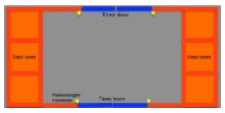
*** **best ratio of sitting and standing room** ***

Calculation:
Seat (60 cm) + foot space (15 cm) = 075 cm X 2 = 150 cm + multi-purpose surface (100 cm).
This module is suitable for vehicles in the PRT / GRT / SMT and for vehicles and trains on suspension railway main lines, for maximum capacity utilization of the line.

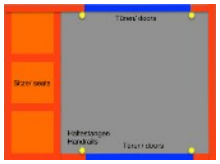
In narrower versions the multi-purpose area is rotated in the direction of travel.
The seat / standing ratio changes to the disadvantage of seats



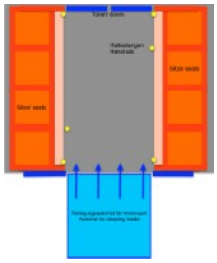
Width: approx. 100 cm,
Length: approx. 350 cm
4 seats, 12 standing, or multi-purpose, 16 passengers



Width: approx. 150 cm,
Length: approx. 350 cm
6 seats, 12 standing, or multi-purpose, 18 passengers



Modules / pods from various planners / manufacturers are shown with three or four seats in different positions. There is space for a bicycle or a wheelchair on an area in front of seats or an area that is created by folding back seats.
Consistently barrier-free?



Machine cleaning possible!

The size of the modules/ pods/ vehicles results from the width of the multipurpose area or the number of seats (200 cm - 4 seats, 250 cm - 5 seats), the profile of the route also plays a role.

The seats are arranged in rows across the direction of travel. The minimum number is four seats next to each other (200 cm). Five seats next to each other (250 cm) can also be discussed.
The seats are assumed to be 50 cm wide (others: from 42.5 cm). (Comfort!)
The seat depth is assumed to be 60 cm.
The foot space is assumed to be 15 cm.
The cabin height (inside) should be at least 220 cm.
Safety: Handrails and loops ensure that passengers have a secure hold.
The cabin should be safe in the event of a lightning strike.
The module / pod / vehicle width should always be the same in a system.
If stations are to be created in the street area, the width of pods should be not more than 220 cm (external dimension). Then the vehicle fits into a station that is in a parking lane next to the road.

The dimensions of the multipurpose area result from the dimensions of the items to be taken.
Here it is assumed to be 100 cm X 200 cm.

A bicycle has a length of about 200 cm, it fits well on the multipurpose space in the cabin.

Enough space for a family outing (1 parent +1 child + 2 bicycles).

Enough space for strollers, walkers and wheelchairs (about 60 cm to 80 cm wide)

Soiling of the clothes of fellow travelers can be avoided as far as possible.

Annotation:

Multipurpose areas that only offer the desired accessibility by converting the seats (folding up, moving) are unusable.

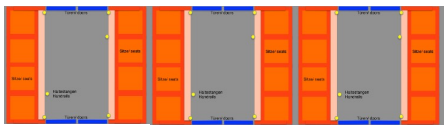
With smaller multi-purpose areas, the cabins are no longer barrier-free!

With smaller multi-purpose areas, the cabins are no longer family-friendly.

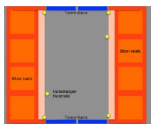
Passenger turnover can be adversely affected with smaller multi-purpose areas.

There are some pods being developed to get lowered into the stations using hydraulics or ropes. In addition to the additional technology and mechanics, which also mean additional weight, the time-consuming maintenance of safety must be observed. The lowering device must lower the pods at least five meters and then raise them again.

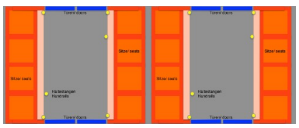
A vehicle can be built from several modules, several vehicles, even of different sizes, can form a train.



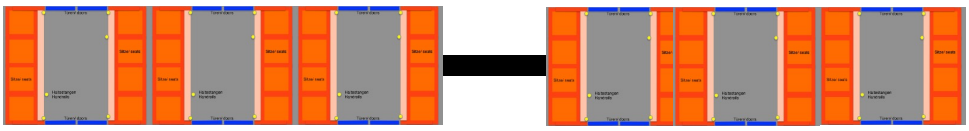
Triple
vehicle of 3 modules



Single
vehicle of 1 module



Double
vehicle of 2 modules



Train of two vehicles with 3 modules each

Comparative values

First some values (without guarantee)

Light rail car "B" 183 passengers, 72 seats, 111 standing places
Tram “Four City Smart” (Skoda) 180 passengers, 72 seats, 108 standing places
Standard bus 80 passengers, 30-35 seats, 50-65 standing places
Standard articulated bus 150 passengers, 50-55 seats, 90-110 standing places

Point of view differences

The calculation of the seat width varies between 42.5 cm and 50 cm depending on the manufacturer.
The calculation of the standing room varies between 35 cm X 35 cm and 50 cm X 50 cm, depending on the manufacturer.

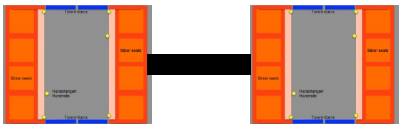
Sky vehicles

Passenger capacity

Single 16 passengers 8 seats, 8 standing places
Double 32 passengers 16 seats, 16 standing places
Triple 48 passengers 24 seats, 24 standing places
Quattro 64 passengers 32 seats, 32 standing places

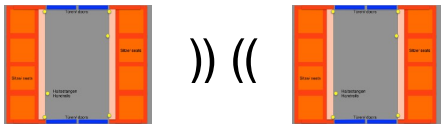
Vehicle sizes

Single length about 400 cm
Double length approx. 700 cm
Triple length approx. 1000 cm
Quattro length approx. 1300 cm



fix coupled train

or



digitally connected

Commitment

Single vehicles are best suited for the **Personal Rapid Transit (PRT) and Group Rapid Transit (GRT)** segment. The distance between the vehicles can be a few seconds only on a section of the route. Vehicle deployments as required are regulated and ensured with depots on the way, for example in the stations.
Changing vehicles should be an option in the GRT.
For the **mass transit (MT)** segment up from around 5000 passengers per hour on a route section (with standard pod), double, triple and larger vehicles are required.
The minimum vehicle distance on the route is greater then.
Even very long trains can run on highly frequented main lines with an independent surrounding structure (stations). (e.g. trains made up of 8 triple vehicles = approx. 90 meters, 384 passengers, corresponding to a tram double traction (360 passengers)).
In times of low traffic, destinations that are not in the line but are in the overall system can be approached directly without having to change trains or pods. (PRT / GRT). Therefore it is a good idea to have small vehicles in the system.
It is possible to offer trips around the clock.

Example of maximum utilization:

A standard articulated bus is replaced by 10 single modules. The omnibus cycle of 10 minutes is replaced by
10 vehicles (single) every minute. PRT possible.

5 vehicles (double) every 2 minutes. PRT questionable.

2 trains (triple, in double traction) every 5 minutes.

Articulated bus 160 passengers every 10 minutes - 6 trips = 960 passengers / h

PRT: 16 passengers X
60 sec = 60 journeys / h = 960 passengers / h
30 sec = 120 journeys / h = 1920 passengers / h
20 sec = 180 journeys / h = 2880 passengers / h
10 sec = 360 trips / h = 5760 passengers / h

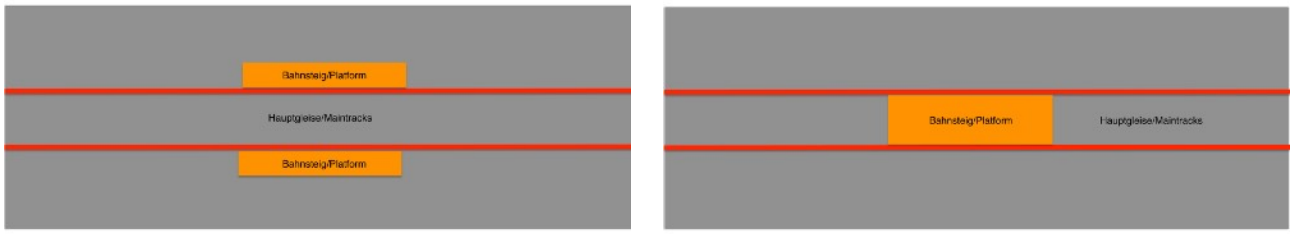
Change your perspective ! Think in small units / PRT/ GRT

On a route on which single pods go every 10 seconds, a maximum of
5760 passengers/ h can be transported.
That corresponds to 36 articulated buses, 72 standard buses or 32 light rail vehicles.

Stations for sky suspension railways in the MT and PRT / GRT

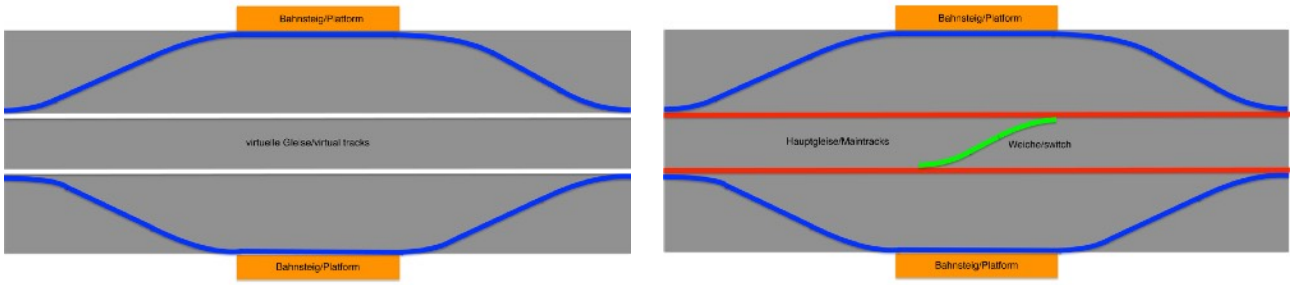
The stations are barrier-free and have platform screen doors (PSDs).
Stations on level +1 without an intermediate level are about 5 meters high (directly above road traffic), stations with an intermediate level are about eight meters high.

Station above the street or in an own building (1a + 1b)



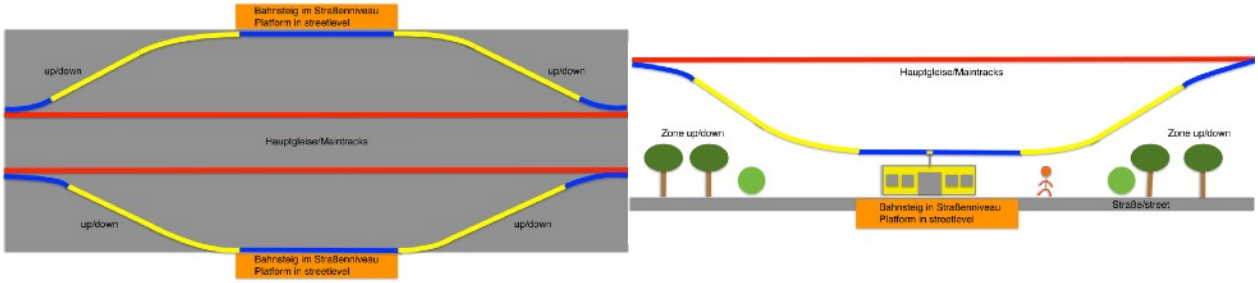
With side platforms or central platform.
Planned over streets, the clearance of the street must be observed.

Station, deflected (2a + 2b)



They are set up in buildings on the street, in development gaps, or even above street crossings, the existing clearance can be preserved most times.
At the stations, the tracks go to side at the stations. Another option is to have drive-through tracks and switches to the platforms.
A switch between the main tracks for shunting should be available at certain intervals.

Station, at ground level (3)

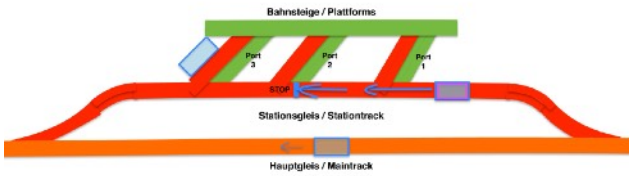


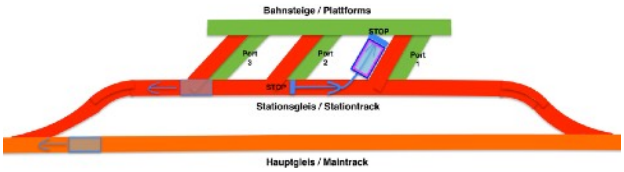
Stairs and elevators are not required. The route in the "up / down areas" and in the stations is to be provided for the exclusive operation of the SkyTrains and to be blocked for other traffic (risk of collision). The specified clearance can largely be retained. They are easier for passengers to reach and offer a better overview - no elevators, no dark corners.

Stations for PRT / GRT

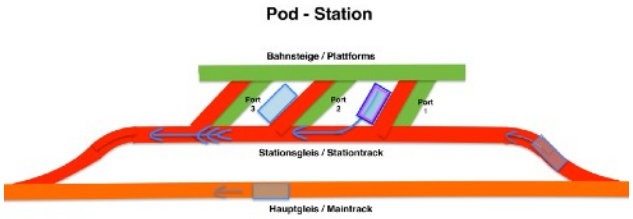
The stations are barrier-free and have platform screen doors (PSDs).
Stations with an intermediate level are about eight meters high, without an intermediate level at about five meters. However, stations at ground level are preferable. They are easier to reach for passengers and offer a better overview - no elevators, no dark corners.
They have main tracks (through tracks) and station tracks.
Pods only stop when requested.
The pods are led from the main tracks over the station tracks to the stopping positions. These can be on the station track or in bays.
In order to avoid traffic jams and disruptions, as many stopping positions as possible are to be kept so pods could enter the station during a stopping process. If a stopping process lasts 30 seconds, for example, 3 more pods can enter the station within this time if the distance between the vehicle is 10 seconds. Up to four holding positions are required. If the distance between the vehicles is greater than 30 seconds, one position or the station track is sufficient.

Conclusion: A greater density of journeys requires larger stations.
Stopping bays are the best way to manage the pods entering, waiting, and exiting. It is thus possible to assign a stopping place to all pods entering the vehicle and to always have a vehicle available to start the journey. If no stopping bays can be created, waiting times can arise because a pod has to come from a distant stopping place for the requested trip.
Protection against vandalism should be considered.



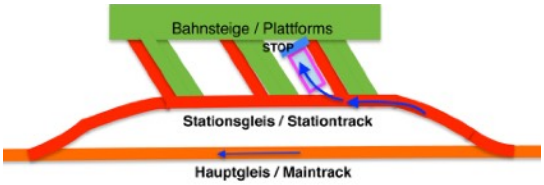


The pods first brake in the station track and slowly reverse into the holding bay.

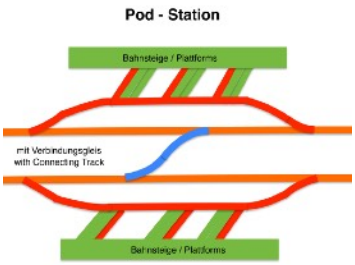


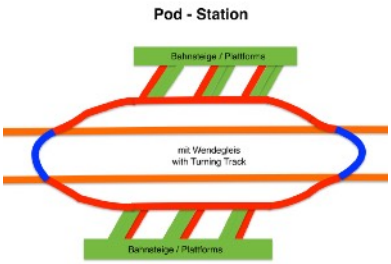
They start forwards from the holding bay and are then threaded into the main track via the station / acceleration track.

If the pods drive directly into the holding bay, there is a risk that the pod will crash into the boundary at the end of the holding bay in the event of technical faults. (Brickwall)



The smallest possible vehicle distance is given as two seconds. Even if the vehicles are 5 seconds apart, there is enough time and space to thread an extending pod into the track and align it.





In order to ensure good distribution of the vehicles, connecting tracks are necessary for bidirectional vehicles and turning tracks when using one-way vehicles.

Stations: More options

Stations should not occupy the clear space of the street too much.

Stations over streets can appear too massive in the existing, evolved settlement image. Residents defend themselves against the "20-meter monster" above their street. It takes the light away from in front of them and their houses. Underneath, it is dark and feels hostile to life. It's one of the reasons why level +1 traffic has been refused so far.

If the stations are set up at street level, for example in the area of parking strips on the side of the street, the vehicles should not be wider than about 220 cm and they should have sliding doors to save space in the station.

At best, stations on a route should be placed opposite one another. If the passenger has to go back, it should take too much time.

Normally, there is no personnel required for driving operations at the stations. (Example Skytrain Düsseldorf)

Tracks

The size of the vehicles and the load with the number of vehicles influence the dimensioning of columns and guideways . Light pods allow filigree guideways.

The "footprint", the space requirement is very small only with stations and columns. (#Land consumption).

Everything can be floated over: impassable terrain, bodies of water, biotopes, meadows, forests and fields, roads, railway lines, buildings, etc.

There is no separation effect between the right and left of the route. Existing structures and uses on the route and in the surrounding area are mostly unaffected.

The normal ride height (lower edge of the vehicle) for stations with stations without an intermediate level is around five meters, for stations with an intermediate level around eight meters. The routes can (also consistently) be created lower (risk of collision with other traffic) or significantly higher. Routes can be created at any defined height.

Tracks should always be laid out in such a way that the privacy of the residents is respected as far as possible.

The noise development of the pods is low, but should be taken into account when designing the route. A very short vehicle sequence of just a few seconds can be expected.

Low sections of the route should be driven more slowly than high sections. The people who move under the railway will welcome this regulation.

Deceleration and acceleration tracks are to be laid out according to the speed and the maximum line occupancy. "Catapult starts" should be avoided.

Two systems are available for crossings and branches, depending on the route load:
Turnout systems with throw-over tracks. There are several levels. Advantage: high capacity
Roundabouts: One level only. Advantage: Does not appear dominant.

There should be “express bridges” in large systems. These are ski routes on a different level at a much higher speed. They connect system sections that are far apart via a few selected stations. There you have a connection to the slower level.

In the close-knit core area where the pods can circulate, single-track sections are sometimes sufficient. In other areas, a radial route pattern can be assumed; a double-track extension is required.

Usually in grown (partly historical) cities there are only a few corridors to set up routes. These are mostly railway lines and large roads, sometimes also green areas or river banks.

Route expansion, speed and route occupancy influence each other.

But there is a particular challenge: routes and stations should be carefully integrated into the established settlement structures.

In special environments, such as airports, docks, exhibitions, leisure packages and “New Towns”, it is easy to find a route for the sky lanes. This is much more difficult in the established, partly historical settlement image, you will have to work with few corridors and routes. These should then also be "graceful", actually invisible.
A PRT route extends up to approx. 5000 passengers per hour.
It can also be difficult to find a route in rural areas. Geography, nature conservation and the respectful handling of the interests of the residents should be reflected in the routing.
If no corridor for a through route can be found in a place, a branch route can provide a connection. The options: transfer to / from the main route (MT) or direct onward journey (PRT).
There is the possibility of setting up freight transport in the suspension railway system.

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