The MaglevTube Puckpodcar for mass urban transportation

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ABSTRACT: This paper discusses the concept and benefits of the MaglevTube Puckpodcar rapid personal transportation system (the MLT system), for which provisional patents were filed early in 2011. The track for the MLT system runs down a tube to protect it from atmospheric conditions such as rain and snow, while wind is generated down the tubes to limit wind resistance. The Puckpodcar uses only rare earth permanent magnets, making it very cost effective to construct and operate, and up to 8 maglev tracks run down the tubes to ensure utmost safety and performance. The MLT solution was designed to provide highly reliable, low cost, high speed mass transportation at a low cost in urban areas and between cities.

1 INTRODUCTION

This paper discusses the MaglevTube Puckpodcar Personal Rapid Transportation solution (MLT System) and how it can be deployed in urban areas as a low cost, high volume, high speed, reliable transportation solution for mass urban transit. The MLT System consists of 3 basic components. First, a high speed meshed tubular track designed for speeds as high as 300km/h in urban areas and even higher between cities. Second, modular Puckpodcars where interchangeable pods are suspended between two pucks, and lastly, high throughput stations catering for 1 000 people or more per minute.

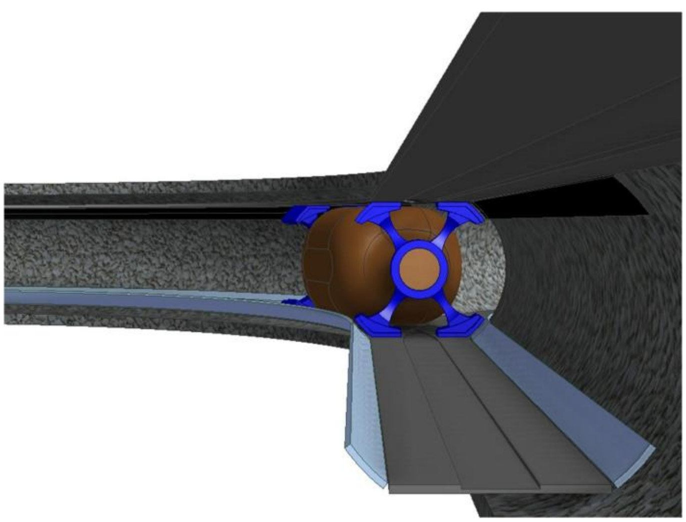

Figure 1. A Puckpodcar running down a MaglevTube.

As can be seen in Figure 1, between 4 and 8 maglev strips are deployed inside the tubes to ensure optimal performance and safety, while wind is blown down the tubes to ensure low wind resistance.

The greatest advantages of the MLT System is its design and engineering simplicity, its relatively low construction cost, its low operating cost and its versatility. The 3 meter diameter tubing encapsulating the track further makes it easy to trench dig the track along any existing road, making it easy to reach just about any area in a city.

Multi-purpose pods makes it possible to use the same pods for transporting people at day and goods at night. By making the pods interchangeable and running different types of pods down the same track, versatility is furthermore increased dramatically. Individuals willing to pay for the solo use of a pod can for instance be transported point-to-point in a six seater pod, much like with a taxi, and 30 seater pods can be used to transport groups of people between hub stations at a much reduced cost per person, much like a bus.

By using permanent rare earth magnets arranged in a Halbach Array on the pucks and combinations of Electro-Dynamic Suspension (EDS) electromagnets and Inductrack-like strips on the track maglev strips, magnetic pollution in the pods are neutralized and electricity requirements for propelling pods minimized.

The MLT System will be one of the easiest to deploy, most versatile, lowest opex and capex cost solutions for mass urban transit available, meeting the needs of most cities the world over. With peak oil clearly looming, as per the Hirch report (Hirch, 2005), cities and governments will soon scramble to find new mass transportation solutions that are also easy and quick to deploy. The MLT system is an ideal solution to meet this need.

2 THE MAGLEV TRACK AND PUCKPODCARS

2.1 The 8 maglev strips running down a tube

The idea of running people and goods in pods down a tube is not new. As early as 1812, George Medhurst published his pamphlet, “Calculations and remarks tending to prove the practicability, effects and advantages of a plan for the rapid conveyance of goods and passengers upon an iron road through a tube of 30 feet in area by the power and velocity of air” (Medhurst, 1812). In 1827, John Vallance proposed such a tube pneumatic transport system to run from Brighton to London, and in 1861 Thomas Webster Rammell even exhibited such a solution in London (Brennan, Chapter 2, p.1).

Medhurst, Vallance and Rammell all realized the same basic benefit of tubes over rails. By running pods down tubes, you have absolute control over the atmosphere, you can run above ground, below ground, under water and on land, and you can use wind or pressure differences inside the tubes to your advantage. No wind or weather or debris or pedestrians can influence the flow of pods down the tube, and wind resistance can be neutralized by moving the air at the same speed as the pods.

And now, almost 200 years later, nothing has changed. Encapsulating the atmosphere around the track in a tube is still the best and most secure way of controlling the cost effective movement of load bearing pods down a fixed path or track. But there is one major difference between then and now, and that is the knowledge and technology we now have to use maglev forces inside the tube to enable movement.

In the MLT System the tube is altered to have a roof and a floor on its inside, thereby creating four corners on the inside of the tube. Maglev strips are run down both sides of each corner, positioning the 8 tracks along four corners of the altered tube, as can be seen in Figure 2. By fitting the four ends of a puck into these four corners, the puck fits snugly into the centre of the tube with only about 2cm space between the puck ends and the maglev strips on the tube wall. As a result, the puck cannot rotate at all and is limited to move either forward or backward.

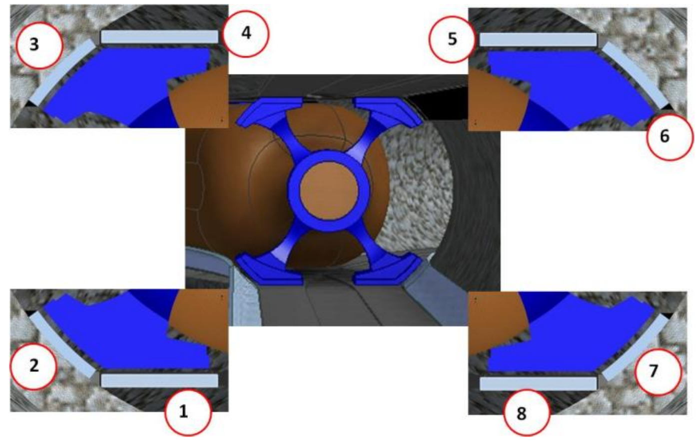

Figure 2: The puck magnets fits tightly into the four “corners” of the central tube where two maglev tracks are positioned in each corner

When running in a straight line down a tube, depending on the specific Maglev technology selected for the track, two to four tracks should be sufficient to enable controlled lift, suspension and linear movement of each puck. When a puckpodcar enters a split in the tube however, the side wall maglev tracks are required to ensure the pucks cannot move away from that side of the tube. When taking the left split, the Electro-Dynamic Suspension (EDS) maglev strips on the left side must ensure that the pucks cannot move more than a few centimeters away from the left side, and similarly on the right side when the puckpodcar is to take the right split. Although the left or right movement will be determined by the main upper and / or lower track maglev strips, the side maglev strips are for extra protection in splits to ensure no Puckpodcar ever runs into a wall in a split in the track.

A range of existing maglev technologies can be used in this design. Electro-Dynamic Suspension solutions, like those developed by Magnemotion, Transrapid, and Applied Levitation, each using no more than two maglev strips for full control, can be used on all 8 tracks. Alternatively, such EDS strips can be used in combination with Inductrack-type strips, running at the floor of the tube to enable low cost lift and suspension. In such a case the EDS tracks, running at the top, will be used only for linear motor movement only.

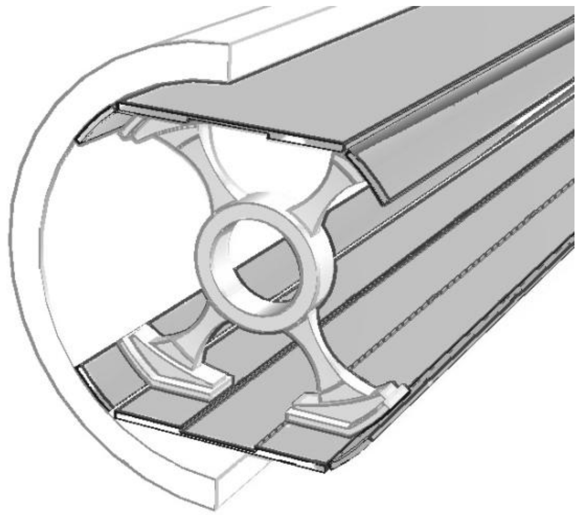

Figure 3: Eight maglev strips run along the tube "corners"

2.2 The high volume, high speed track

Using Maglev tracks and wind running down the tubes to limit wind resistance, the puckpodcars will be able to run at speeds limited only by the design of the track and the effect of skin drag inside the tube. Since the MLT solution is a Personal Rapid Transportation (PRT) solution, the principles of PRT track design are used. Automated Puckpodcars can run tightly packed along a single lane track, as long as they all move at the same speed in the same direction on the same track sections. Fixed speed track sections are linked to each other using acceleration and deceleration zones.

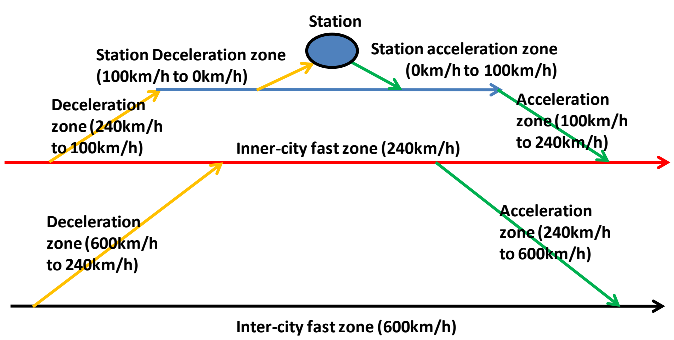

Figure 4. The higher the speed on the fixed speed sections, the longer the acceleration and deceleration zones will be.

By inter-connecting various loops of track to each other, a plurality of stations can all be connected to each other, enabling point-to-point transportation at speeds of 240km/h or more in cities and 600km/h or more between cities. To lower transportation costs for the mass population, station hubs can dynamically be created as and when the demand justifies it. When choosing a low cost option, a person will be required to climb over at a hub station, once or twice in a single trip, to share larger pods with others moving to the same destination hub or station. People choosing this option will be gathered at various stations in a specific loop in small, 6 seater pods, climb over into shared 30 seater pods at the hub, be transported to the same destination hub, where they can again be disseminated into small 6 seater pods and onwards to their respective stations. This way, optimal efficiencies in mass transportation can be achieved, while those that want to pay for private use and the luxury of point-to-point travel will have that option too.

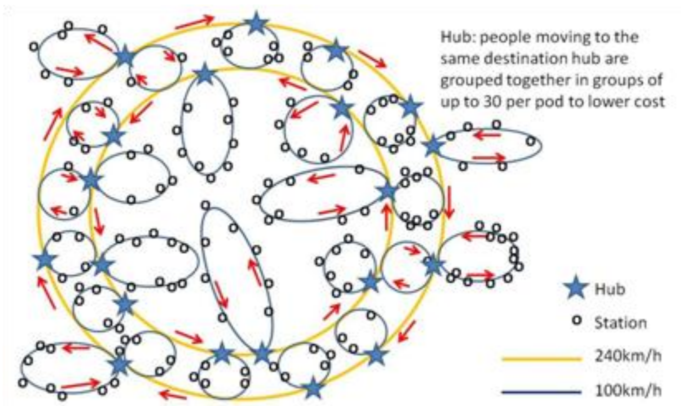

Figure 5. Interconnected "loops" enable hub-and-spoke models as well as higher speeds over longer distances.

2.3 The high throughput station design

No matter how high the speed of the track and the puckpodcars, if the stations cannot handle the quick loading and offloading of a large number of passengers, while always having empty pods available, on demand, the system will not be effective.

In order to address this issue, the MLT System uses a modular station design where all stations consist of large cavities with a flat roof and flat floor, with up to 12 access gates at each side, and a holding area for empty pods at its centre. Since the pucks do not have to run in tubes but simply need a flat roof and flat floor to run between, these station cavities require EDS maglev roofs to enable controlled movement and a strong floor upon which Puckpodcars can run on wheels instead of Maglev feet. A single station cavity with gates at one or both sides can make up a small station, whereas larger stations consist of multiples of these smaller station cavities, arranged in such a way that passenger platforms have gates on both their sides, as can be seen in Figure 6.

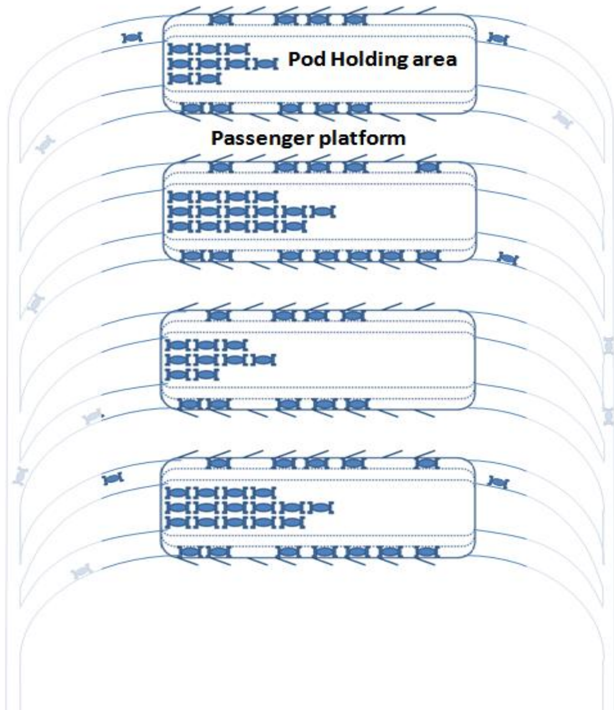

Figure 6. The MLT System stations consist of single station components, modularly stacked next to each other to form bigger and bigger stations

If each single station segment in a large station has 10 gates on each side, and the large station consist of 6 such single station cavities, and each pod takes on average 4 people at a time, and it takes 1 minute from loading a pod to loading the next pod at the same gate, then the station can load and offload 480 passengers per minute.

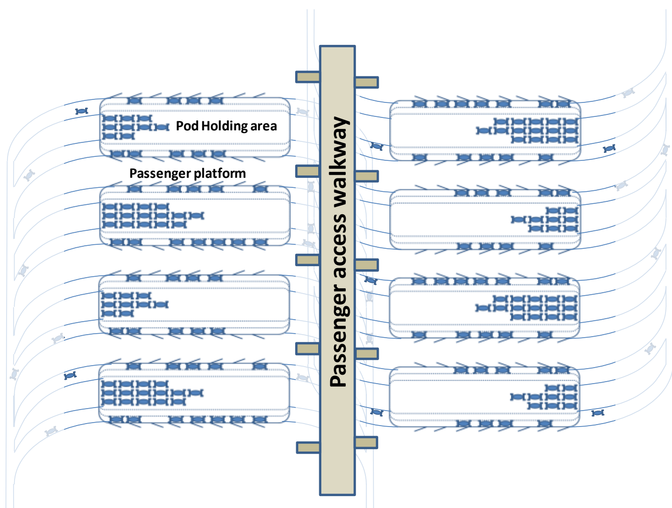

Figure 7. Double layering enables the creation of stations that can handle in excess of 900 passengers per minute

By double layering the station, as can be seen in Figure 7, the large station can be used to load and offload 960 passengers per minute, or close to 60 000 per hour. A single very large shopping centre or complex can for instance have as many as four such double layered stations at each end of the centre, giving it the capacity to load and offload as many as 3 840 passengers per minute or more than 200 000 per hour. This in less space than that taken up by parking lots at such centers at present.

3 CONSTRUCTION AND RUNNING COSTS

A test system is yet to be built, therefore accurate costing is not available at present. However, a simple analysis of the system makes it clear that costing should be much lower than that of existing or competing system.

Lightweight puckpodcars

The Pucks are made of strong, lightweight materials fitted with permanent rare earth magnets at the four ends. No power sources, electrical or electronic components need to be carried on the pucks, making their construction simple and cost effective. Similarly, the pods that together with two pucks form a puckpodcar, are also made from lightweight materials commonly used in the airline and automotive industries. A small puckpodcar carrying up to 6 passengers should weigh less than 800kg and cost less than the average family sedan to manufacture.

As proven by the research team from the Lawrence Livermore National Laboratory (Post, 2000) that developed the Inductrack system, permanent rare earth magnets arranged in a Halback Array moving over copper coils in the track will not only elevate, but be able to lift up to 50 times its own weight. In the MLT System, the bottom four maglev strips in the tube can potentially consist of copper loops, as per the Inductrack solution, and the top four strips of tightly packed EDS electromagnets, as per the Transrapid, Magnemotion M3 or Applied Levitation linear motor solutions, amongst others.

Because it is running in a tube where the Maglev tracks are positioned on all sides around the puck, stability can be assured by the four side maglev strips, the two bottom strips can be used for elevation, and the two top strips can be used for linear movement only. The only other energy requirement would be for the generation of constant wind down the tubes to eliminate wind resistance.

Using the above configurations, logic dictates that the light weight of the puckpodcars, the low cost of the bottom strips, and the low energy requirement of the top strips that are used only for linear movement and not magnetic levitation, would make for a relatively low cost construction and operating model.

Concrete tubes

The tubes the Puckpodcar tracks are laid in are 3 meter diameter pipes primarily constructed from reinforced concrete, similar to water and drainage pipes deployed in all large cities. Although the concrete pipes would be treated with other materials on its inside to ensure the lowest possible skin drag, the cost is still very low compared to that of overhead guideways and other rail or PRT tracks.

Tubes also have a number of other cost advantages. They can be laid on the ground, underground, under water or on top of overhead guideways. To lay a tube underground, either tunneling or trench digging can be used. When tunneling is required, the cost would be much, much lower than road or rail tunneling due to the small diameter of the tubes. In the case of trench digging, lesser used side roads can be trench dug to reach almost any area in a city without disrupting traffic dramatically or constructing high cost overhead structures. More than one tube can also be put in the same trench, turning a small side road into a corridor with the same carrying capacity as a major highway.

4 CONCLUSIONS

The MaglevTube Puckpodcar transportation system was designed as a low cost, high speed, highly flexible mass transportation solution to meet the needs of modern societies in a time when fossil fuel based transportation is becoming less and less reliable. A more flexible, safer, faster or more reliable system running more energy efficiently is hard to imagine. However, the final test that will determine the success or not of the adoption of the MLT System will be the political will or not of those currently overseeing a fossil fuel based economy and its interests.

George Medhurst, the pioneer of the concept of tube based transportation, in 1827 published a paper proposing a wind driven tube system running pods all across England with the title “A new system of inland conveyance for goods and passengers capable of being applied and extended throughout the country and capable of conveying all kinds of goods, cattle and passengers with the velocity of sixty miles an hour at an expense that will not exceed the one fourth part of the present mode of travelling without the aid of horses or any animal power” (Medhurst, 1827). Almost 100 years before the commercialization of the automobile, imagine what could have been had Medhurst have access to the right technology and political backing to pull his invention off. With technology having caught up with old ideas, the more appropriate question now is, what can be!

5 REFERENCES

Medhurst, George. 1812. Calculations and remarks tending to prove the practicability effects and advantages of a plan for the rapid conveyance of goods and passengers upon an iron road through a tube of 30 feet in area, by the power and velocity of air, London.

Medhurst, George. 1827. A new system of inland conveyance for goods and passengers capable of being applied and extended throughout the country and capable of conveying all kinds of goods, cattle and passengers with the velocity of sixty miles an hour at an expense that will not exceed the one fourth part of the present mode of travelling without the aid of horses or any animal power, London.

Post, Richard P & Dyutov, Dmitri D, IEEE Transactions on Applied Superconductivity, March 2000, Volume 10, n. 1, pp. 901□904, doi:10.1109/77.828377

Hirsch, Robert L & Bezdec, Roger & Wendling, Robert, Peaking of world oil production: Impacts, Mitigation and Risk Management, US Department of Energy, 2005

Thornton, R.D; Clark, T; Perreault, B, Linear synchronous motor propulsion of small transit vehicles, Proceedings of the 2004 ASME/IEEE Joint Rail Conference, April 2004

Fiske O.James. et al, “Magnetically levitated transportation system and method”, U.S. Patent 6684794, 2004

Long, Geoffrey. A, Fiske O. James, Paden, Brad. E, Design of a small-Scale Prototype for a Stabilized Permanent Magnet Levitated Vehicle, Paper 88, Maglev2008 Conference, December 2008