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The Hyperloop High-Speed Train

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Back in 2012, Tesla Motors and SpaceX founder Elon Musk made news when he announced his idea for a “fifth form of transportation”, one that would supplement the existing methods of travel by boat, rail, plane and automobile. Known as the Hyperloop, the concept called for the creation of a high-speed train that would use a low-pressure steel tube and a series of aluminum pod cars to whisk passengers back and forth between San Francisco and LA.

A year later, he released an “Alpha Paper” describing the concept in detail. Hyperloop is a new mode of transport that seeks to change this paradigm by being both fast and inexpensive for people and goods. It is also unique in that it is an open design concept. Feedback is desired from the community that can help advance the Hyperloop design and bring it from concept to reality.

Hyperloop consists of a low pressure tube with capsules that are transported at both low and high speeds throughout the length of the tube. The capsules are supported on a cushion of air, featuring pressurized air and aerodynamic lift. The capsules are accelerated via a magnetic linear accelerator affixed at various stations on the low pressure tube with rotors contained in each capsule. Passengers may enter and exit Hyperloop at stations located either at the ends of the tube, or branches along the tube length. The initial route, preliminary design, and logistics of the Hyperloop transportation system have been described. The system consists of capsules that travel between

Los Angeles and San Francisco, California. The total trip time is approximately half an hour, with capsules departing as often as every 30 seconds from each terminal and carrying 28 people each. This gives a total of 7.4 million people each way that can be transported each year on Hyperloop.

The total cost of Hyperloop is under \$6 billion USD. Amortizing this capital cost over 20 years and adding daily operational costs gives a total of about \$20 USD plus operating costs per one-way ticket on the passenger Hyperloop. This transit system would theoretically be able to achieve supersonic speeds of up to 1280 km/h (800 mph) [1], and make the trip from San Francisco to LA in just 35 minutes.

The current practical modes of transport for passengers between these two major population centers include:

1. Road (inexpensive, slow, usually not environmentally sound)
2. Air (expensive, fast, not environmentally sound)
3. Rail (expensive, slow, often environmentally sound)

A new mode of transport is needed that has benefits of the current modes without the negative aspects of each. This new high speed transportation system has the following requirements:

1. Ready when the passenger is ready to travel (road)
2. Inexpensive (road)
3. Fast (air)
4. Environmentally friendly (rail/road via electric cars)

It is also worth noting the energy cost of this system is less than any currently existing mode of transport.

The only system that comes close to matching the low energy requirements of Hyperloop is the fully electric Tesla Model S.

The Hyperloop consists of several distinct components, including:

1. Capsule:

a. Sealed capsules carrying 28 passengers each that travel along the interior of the tube depart on average every 2 minutes from Los Angeles or San Francisco (up to every 30 seconds during peak usage hours).

b. A larger system has also been sized that allows transport of 3 full size automobiles with passengers to travel in the capsule.

c. The capsules are separated within the tube by approximately 23 miles (37 km) on average during operation.

d. The capsules are supported via air bearings that operate using a compressed air reservoir and aerodynamic lift.

2. Tube:

a. The tube is made of steel. Two tubes will be welded together in a side by side configuration to allow the capsules to travel both directions.

b. Pylons are placed every 100 ft. (30 m) to support the tube.

c. Solar arrays will cover the top of the tubes in order to provide power to the system.

3. Propulsion:

a. Linear accelerators are constructed along the length of the tube at various locations to accelerate the capsules.

b. Stators are located on the capsules to transfer momentum to the capsules via the linear accelerators.

4. Route:

a. There will be a station at Los Angeles and San Francisco. Several stations along the way will be possible with splits in the tube.

The Hyperloop is sized to allow expansion as the network becomes increasingly popular. The capacity would be 840 passengers per hour which more than sufficient to transport all of the 6 million passengers traveling between Los Angeles and San Francisco areas per year. In addition, this accounts for 70% of those travelers to use the Hyperloop

during rush hour. The lower cost of traveling on Hyperloop is likely to result in increased demand, in which case the time between capsule departures could be significantly shortened.

However, ElonMusk, the founder of Tesla Motors, indicated that he was too busy to build such a system, but others were free to take a crack at it. And a small startup from El Segundo, California is prepared to do just that. That company is JumpStartFund, a startup that combines elements of crowd funding and crowd-sourcing to make innovation happen.

This included bringing together 100 engineers from all over the country who work for such giants of industry as Boeing, NASA, Yahoo!, Airbus, SpaceX, and Salesforce. By their own estimates, they believe they can complete the Hyperloop in just 10 years, and at a cost of \$16 billion.

Linear electric motors would also be placed at each destination to slow the pods down by absorbing their kinetic energy, which would then be put back into battery packs and used to accelerate the next pods, or stored for future use. Solar panels on top of the tubes would also provide energy. Much has been made of the tube-aspect of the idea, and has often led to comparisons being made to the kinds of pneumatic tubes that were used to send messages around office buildings in the mid-20th century.

And of course, there's still plenty of logistical issues that need to be worked out, not to mention the hurdles of zoning, local politics and environmental assessments, but it quickly becomes apparent just how dramatically the Hyperloop could change transportation.

References:

1. Mode of access: http://www.spacex.com/sites/spacex/files/hyperloop_alpha-20130812.pdf. – Date of access: 05.04.2017.