HyperOps Abstract Submission

(Team ID: HO-211766)

Problem Definition:

The hyperloop is a proposed high-speed transportation system for both passenger and freight transport. With a speed that is 3x faster than high-speed rail and more than 10x faster than traditional rail, the arrival and departure of the pods at the pod bays take place within the gap of a few minutes unlike the hours-long wait at an airport or train station. Therefore, without a properly planned passenger flow system, it would be impossible to control the hysteria at the portals due to thousands of passengers rushing to board their pods within their allotted timings and multitudes of pods rushing into and out of the portals within the time gap of a few minutes. Aiming to provide a luxury travel experience to each and every passenger, we designed this idea so as to optimize passenger flow within a theoretical Mumbai portal and provide smart, efficient and a comfortable passenger experience at all times.

Objectives:

- Optimize passenger flow
- Reduce dwell time
- Allows pods from different platforms to form a convoy thereby reducing time and increasing efficiency
- Passenger crowding minimalized
- On demand booking
- Smooth and fast journey from beginning till the end
- Passengers can pick the time (in mins) at which they would like to start their journey.
- Only a minimum number of itinerary changes is required if 1 or more pod bay shutdowns

Introduction to the proposed solution:

Our design aims at providing an organized and continuous convoy movement that allows users to book pods on demand as and when they wish to board their pods.

The theoretical Mumbai portal has 13 platforms with each platform having 6 pod bays that collectively make up a convoy (of 6 pods). In our concept, pods always try to travel in a convoy of 6 making the journey all the more energy efficient. We also included the fact that a convoy shall always leave from a single platform. Pods from different platforms can't make up a convoy in our case. The convoys come and go at a fixed frequency which can be altered

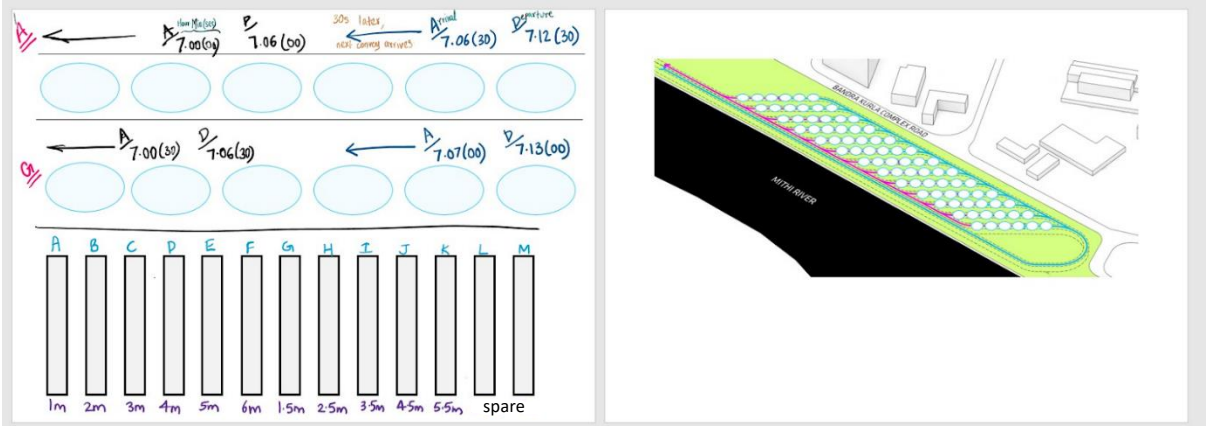
according to passenger traffic. Passengers can book their pods depending on their preferred choice of timing (i.e. the time at which they are confident they would be able to board their pod by)

The passengers shall either book their tickets (contains: Platform number, Pod Bay number and seat number) in advance through the hyperloop's official software application or through on-spot booking at the portal depending on the availability. As a passenger enters through a ticket counter, their tickets are either booked or verified and on approval they may proceed to the concourse area. Here, one must scan their ticket at the AFC gate (when you scan it at the AFC gate, it checks for validity. If it is valid for exit or entry, then the gate will be opened, otherwise, it commands the user to go to customer care.) and the gate opens in the direction of the paid area of the concourse. From here, they may easily navigate to their platforms with the help of sign boards provided at sufficient intervals throughout the portal. The escalators take them from the concourse to the platform levels. (If possible, the Virgin hyperloop portal could be equipped with a transit train connecting platforms so as to reduce the time and distance the passengers would have to cover whilst navigating to their platforms). Upon reaching the pod bay the passenger may proceed to get inside the pod and take their seat.

At the peak hour, we plan to send the convoy for its departure within 6 mins (minimum dwell time of pod at podbay) of its arrival at the platform. 30 seconds later (minimum headway between 2 convoys) a new convoy may arrive to fill the now vacant platform.

The key idea behind our approach is that each platform is assigned a time (in mins) at which all the pods of that platform shall leave i.e. a single convoy always leaves from a single platform. This is done keeping in mind that in the given case the number of portals is only 2. So, the pods need not split from the convoy to reach its destination as all the pods are intended to reach either one of the 2 given portals. At peak hours, the time for each alternative convoy to leave can be reduced up to the minimum headway between convoys i.e. 30s. This case is depicted below.

Let the 1st pod on platform A leave in 1 min time (assuming that it has covered the minimum dwell time of 6mins) and 1st pod of B in 2mins and so on. Since the minimum headway between convoys is 30s, there could also be a time interval of half a minute as shown in the figure below. In this high traffic case, the platform F leaves in 6 mins which is also the minimum dwell time. Platforms L and M are kept as spare and shall not let passengers in unless in an off-scenario case of 2 pod bays going out of service. This is further explained in detail below.



In case of lesser traffic, the headway between convoys can be increased from 30s (such that the wait time from the proposed arrival time of the next convoy does not exceed 6 mins so as to ensure that the maximum passenger wait time at platform will be <6 mins) to let more passengers occupy a single convoy.

This procedure lets the passengers pick their convenient time (in mins) at which they would like to start their trip despite traffic issues.

Once the convoy reaches its destination, it looks for an available platform which will be known from the pre-planned itinerary (depicted below) and docks over there. The passengers shall then either exit the portal directly or may head to the amusement areas such as the rooftop park, coffee shops etc. to make the most out of their experience!

Calculations for passenger flow in 1 hour during peak hour:

Assumption: approx. 16000 passengers at peak hour (ie. 16k passengers transported within an hour)

1 pod = **28 passengers**
1 convoy = 6 pods = 28x6 = **168 passengers**
78 - max pods in a portal at a time

According to above stated design plan:
In the high traffic scenario: 16000 passengers.
16000/168= 96 convoys (16128 passengers) required to transport 16k passengers in 1 hour.

A convoy stays at a platform for 6 mins and after 30s, the next convoy arrives. Thus, after 6m30s (390s) from the arrival of the first convoy, the next convoy in the same platform takes its place.
Thus, in 1hour: up to 9 convoys (1512 passengers) leave a platform.
ie. from 13 platforms, 117 convoys (19,656 passengers)

3600/30 = 120 convoys => (120*6) = 720 pods per hour
No.of pods that can travel in 1 hour (3600s) = 572 pods/hr (16k passengers)

Given: Min. dwell time of pods (in this approach, a convoy) = 6mins
Min. headway between 2 convoys = 30s
Peak passenger traffic/hr = 16000
Therefore, a platform with a departing convoy will be occupied again in 6.5mins.
This implies that 9 convoys/platform/hr embarks the journey, i.e. 1512 passengers/platform/hr.

Since 16000 is the peak traffic/hr, (to find no.of functioning platforms required)
1512 * (x platforms) = 16000
1512 * 11 = 16632 passengers
632/28 ~ 22 pods ~ 4 convoys (extra)
The extra 632 passengers will occupy 4 convoys (which is to be subtracted from total)

4 convoys = 672 passengers (96-4 = 92 convoys/hr/direction)
16632-672= 15960 passengers (<16000)

Therefore, only 11 platforms need to function whilst satisfying all the given constraints. The other 2 spare platforms could be used in case of an off-scenario case of when 2 pod bays are out of service. During high traffic, the convoys can leave with the minimum head time of 30s between each of them thus achieving maximum passenger flow efficiency and revenue.

Solution to off-nominal scenarios:

1. How would we manage an off-nominal scenario and maintain passenger flow when 2 pod bays are out of service at one time?

Due to the above approach, it becomes very easy to tackle the scenario of when 2 pod bays go out of service. In such a case the 2 spare platforms will be put to use. The platforms containing the mentioned pod bays will have its passengers shifted to these two spare platforms. The functioning of the entire system continues without any trouble or delay for any passenger.

2. How would we manage passenger traffic into and out of the portal via different modes of transport? (i.e. pedestrian, private vehicles, taxis, metro, and high-speed rail).

We plan to incorporate the use of various nearby/available transportation modes for passengers to travel directly into and out of the city with ease. The key element to our idea being the upcoming Metro station and the high-speed rail at the Bandra Kundla Complex. If possible, the Virgin company could initiate a shuttle bus facility at the portal to take passengers to the Metro/high speed rail station due to which the passengers shall have an immediate solution to travel further into the city once they reach the Mumbai portal.

As for the cyclists and pedestrians, a separate walkway could be made for them to ensure their safe entry and exit from the portal. Taxis and private vehicles, once entered, will be directed to the Pay&Park area where they'll have to collect their parking ticket (upon which one can also predict the number of passengers that intend to enter the portal) and then proceed inside. A smart LED parking light system with sensors can be implemented in the parking lots to ensure that passengers won't face any difficulty in finding an empty parking space.
A pickup and drop area (with preferably a max wait time of 10 mins) may be arranged near to the portal entrance.

Current Development Stage:

The software for the system allows passengers to pick a time (in min) and purchase the corresponding ticket. The digital ticket shall display the gate number consisting of the platform number(A-M) and pod bay number(1-6) and the seat number (eg: E2 3a)
The software is planned to connect with the inbuilt map of the portal that directs passengers to the required locations.

Novelty of Approach:

The off-scenario case of 2 pod bays going out of service is tackled very easily with the 2 spare platforms kept non-functional unless in the above-mentioned case. Doing this does not affect passenger intake or target utilization rate as the passenger traffic stays within and almost equal to the given peak passenger traffic per hour in peak hours.

The approach we have taken enables passengers to pick a time slot (in mins) to begin their journey. This lets passengers pick their convenient time rather than depending on when the pods shall leave.

Passenger flow is made very smooth and enhanced to give the passengers the best experience even when pod bays go out of service. Only those platform passengers will have to be shifted to the spare platforms thus increasing the speed of the process of reallocation. No other platform passenger flow is disrupted either.

Links the portal to nearby Metro/high speed rail stations which can be reached from the portal via shuttle buses, thereby allowing the passenger to have a quick and comfortable journey not only till the hyperloop portal but also further towards their destination within the city.