Paradigm Hyperloop – ECE Design Challenge:

Precisely Measuring Position (or Distance) of a pod in the Hypertube:

What technologies are used to measure position/?

GPS Tracker:	
Pro: • Wireless tracking, which can send data to computer directly.	Cons: • Requires batteries • More expensive than other options. • Unreliable indoors.
Comments/Options: Can use a programmable GPS device that can connect to a cell network and have it send positional information to be processed. (range and signal strength inside tube? Conversion from longitude and latitude data to relative distances?) Arduino GPS Module (https://playground.arduino.cc/Tutorials/GPS) - • If used, how to extract/access data?	

Electronic Compass:	
Pro: • Provides redundancy and can aid in testing of chosen positioning system.	Cons: • probably too redundant (lool)
Could be used for getting directional data and combine it with GPS information. • If track is looped at the ends of straightaways, Electronic compass can detect when we are turning and (**somehow**) send data. • Adds a bit of redundancy to GPS tracking system wherein the direction is obtained through 2 means. https://www.youtube.com/watch?v=zo_ZA-SmXtg	

Wifi Mapping:

Article: (WiFi-based Enhanced positioning systems: Accuracy through Mapping, Calibration, and Classification):
- "Can provide seamless positioning service indoor and outdoor"
- can be optimized to nearly reach GPS accuracy.

Article (Improving indoor positioning precision by using received signal strength fingerprint and footprint based on weighted ambient WiFi signals):
- most indoor positioning systems rely on on RSSs (received signal strengths) from indoor emitting devices – Wi-Fi Aps(access points).
- By collecting RSSs from intrinsic and extrinsic APs, filtering RSSs by direction/orientation, proposed schemes can overcome signal instability problem in indoor environment.
- Weighted voting positioning (WVP) algorithm would assign higher reference weights to signals from intrinsic Aps and adjust weights to signals from extrinsic APs by their failure probability.

Article 3 (A Real-Time Location-Based Service Using Wi-Fi Fingerprinting algorithm for Safety Risk Assessment of Workers in Tunnels):
- Features "Component overview of a real-time monitoring system"
- Current methods of most Positioning system based on Wifi using RSS are divided into two groups: (1) *Trilateration* – "estimates target position by measuring distance between target and at least three known reference points points" and (2)- *fingerprinting* – "gets the target location by matching fingerprint information, which is characteristic signals"
- From Wiki: Fingerprinting based localization: relies on recording of signal strength from several access points in range and storing info in database along with known coordinates of client device. During tracking phase, RSSI (RSS indicator) at unknown location is compared to those stored in fingerprint and closest match is returned as the estimated user location. (may provide median accuracy of 0.6m and tail accuracy of 1.3m).

Pros:	Cons:
• Algorithms are already made, just need to implement most appropriate one. • Relatively inexpensive solution. • Do not suffer from accumulated error	• Calibration of position can be tedious. • Changes to environment can change the fingerprint that corresponds to each location. Would require updating fingerprinting database. • Security of network. • How is accuracy and uncertainty affected by high speeds of the pod?

	• Should we have multiple RSS/Wifi Sensors on the Pod? If so How many?

IMU (Inertial measurement Unit):	
Pro:	Cons:
• Does not require external references. • Used in Ships, aircrafts, submarines, and spacecraft's. • Could be (IS) used to supplement other navigation systems.	• Suffers from accumulated error (integration drift). As pod moves further from starting point, error in position is increasing.
Inertial Measurement Unit: • Measurement provided by accelerometer and gyroscope are used to track position and orientation of an object relative to starting point. By processing signals from device, it is possible to to track position and orientation of object.	

Best to use complementing technologies as well.