MAGNETIC LEVITATION

(MAGLEV)

CONTENT

MAGNETIC LEVITATION (MEGLEV)

MAGLEV = MAGNETIC + LEVITATION

- Any thing which may levitate(raise or float) by means of a magnetic power is simply called as magnetic levitation.
- **Magnetic levitation** or **maglev**, is a method by which an object is suspended or float with no support other than magnetic fields.
- It's the electromagnetic force counteracting the gravitational force.

MAGNETIC LEVITATION (MEGLEV)

LEVITATION :

➢ Meaning :

- A Latin word meaning lightness.
- Process by which an object is suspended by a physical force against gravity, in a stable position without any solid physical contact.

➢ Principle :

- First a force is required vertically upwards and equal to the gravitational force.
- Second for any small displacement of the levitating object a returning force should appear to stabilize it.

HISTORY

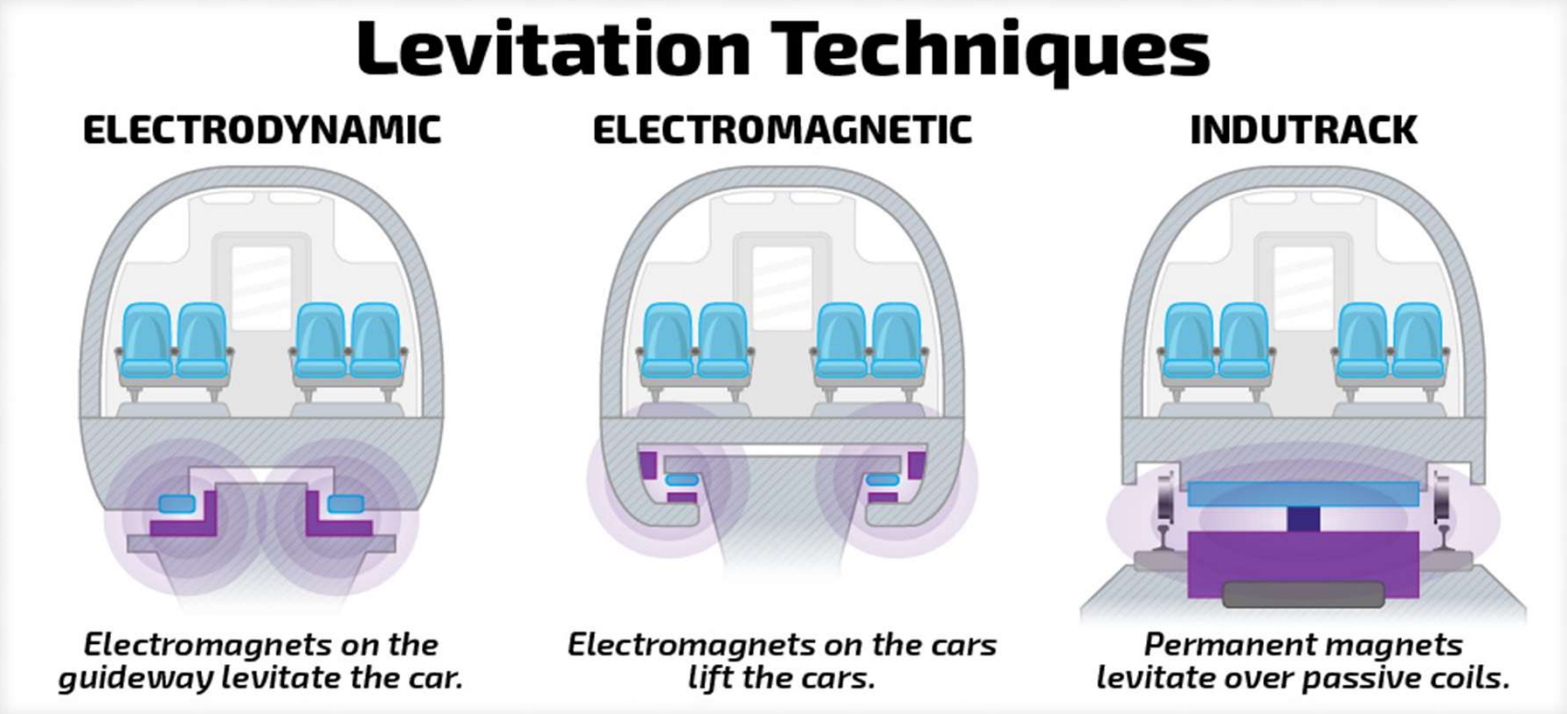
- First described by Robert Goddard, American Rocket Scientist, 1909 Scientific American.
- Later in 1937 & 1941 a series of German patents for maglev trains propelled by linear motors awarded to Hermann Kemper.
- in the 1960s in Britain Eric Laithwaite developed a functional maglev train.
- **The highest recorded speed of a maglev train is 581 km/h (361 mph), achieved in Japan in 2003.**

NEEDS OF MAGLEV TRAIN

- Increasing pollution level from automobiles
- Depleting fuel resources
- Limited range of buses and cars
- Speed and efficiency

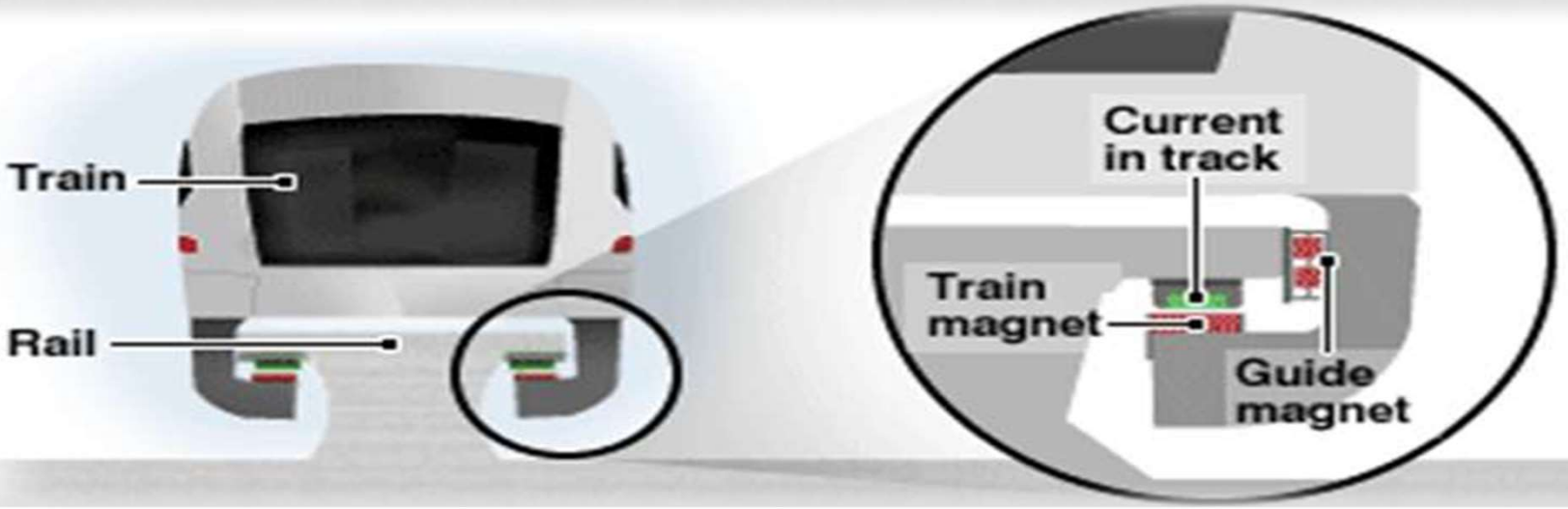
MAGLEV TECHNOLOGIES

- There are 2 notable types of maglev technologies:
  - Electromagnetic suspension(EMS)
  - Electrodynamic suspension(EDS)



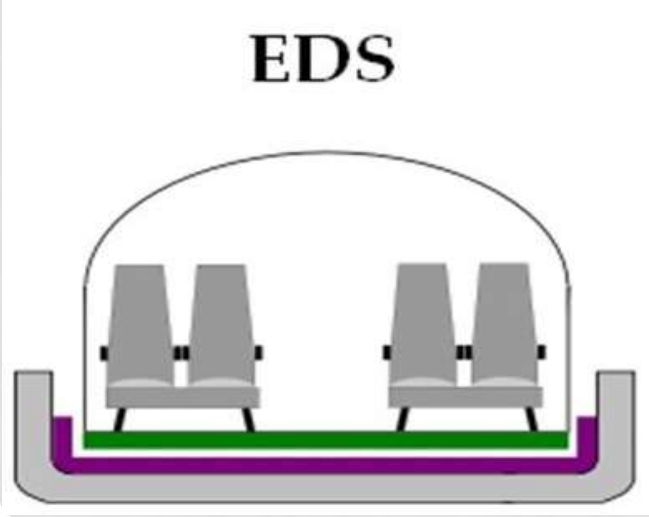
ELECTROMAGNETIC SUSPENSION(EMS)

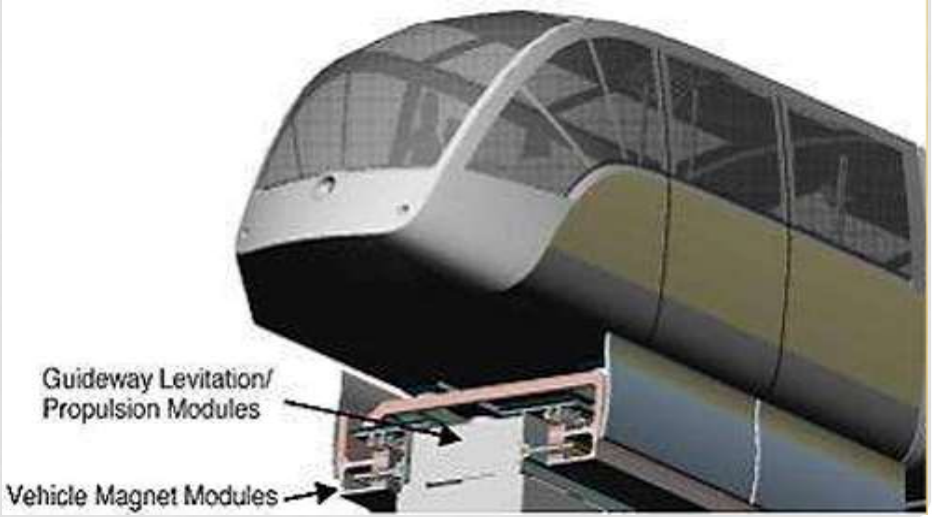
- Electromagnets attached to the train.
- Has ferromagnetic stators on the track and levitate the train.
- Has guidance magnets on the sides.
- A computer changes the amount of current to keep the train 1 cm from the track.
- Max speed - 438km/hr.
- Has on-board battery power supply.



ELECTRODYNAMIC SUSPENSION (EDS)

- Super cooled superconducting magnets under the train. Levitate about 10 cm.
- The field in the train due to superconducting magnets(JR-Maglev) or an array of permanent magnets (Inductrack).
- The force in the track is created by induced magnetic field in wires or conducting strips in the track.
- Requires retractable wheels at low speed , max speed – 522km/hr.

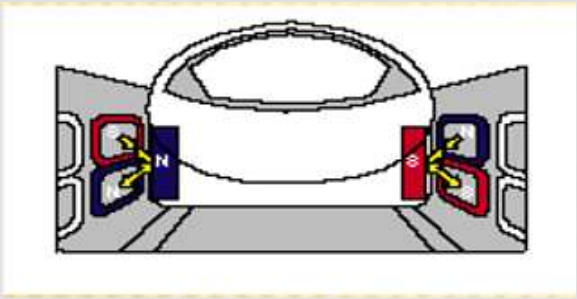




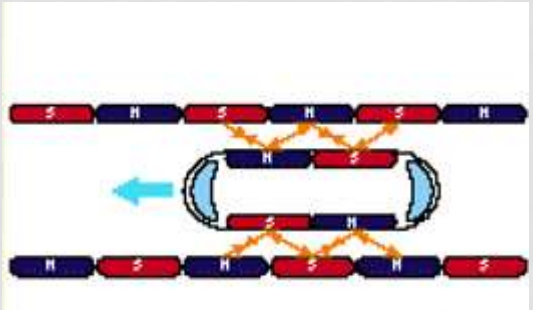
BASIC PRINCIPLE OF MAGLEV TRAINS

- Maglev trains have to perform the following functions to operate in high speeds

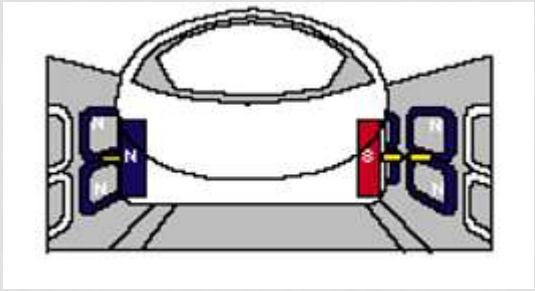
1. Levitation

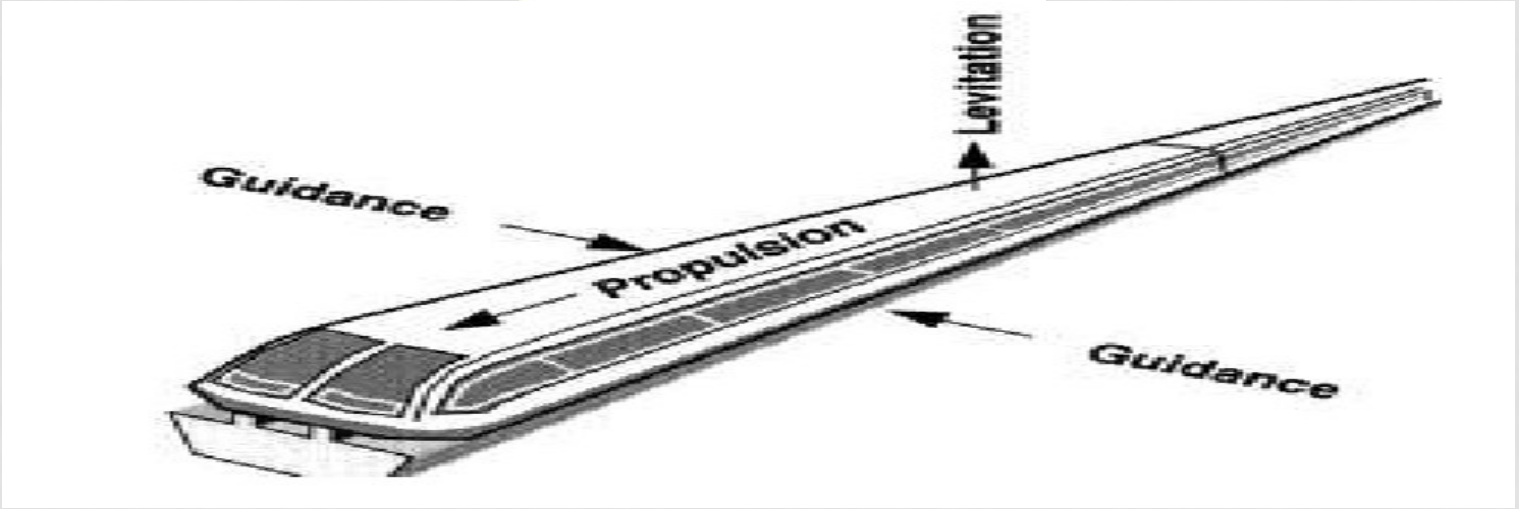


2. Propulsion



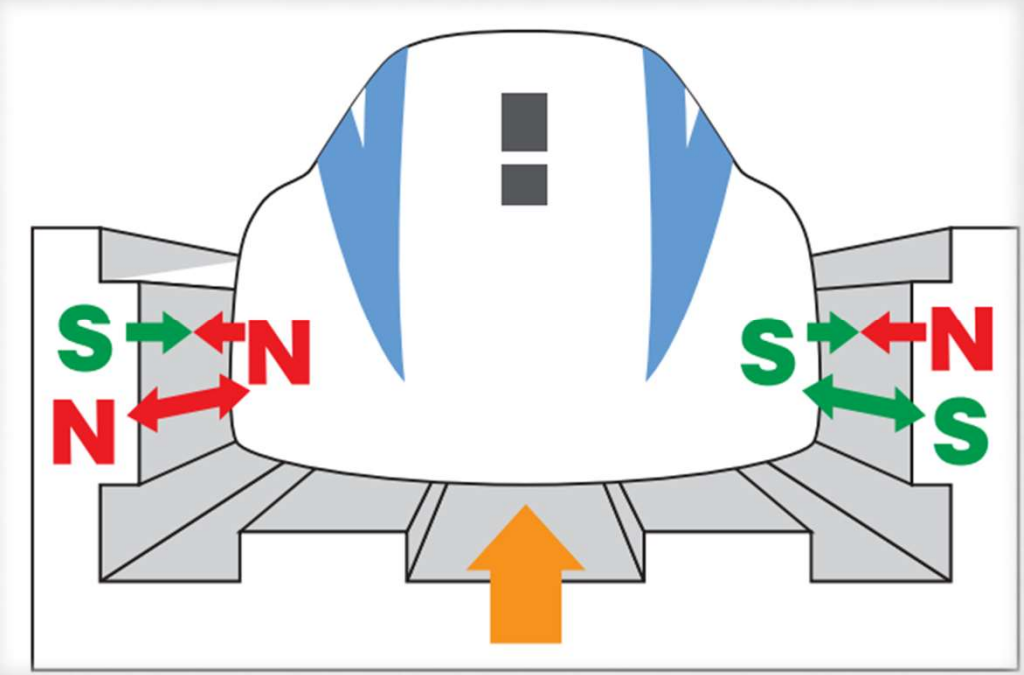
3. Lateral Guidance





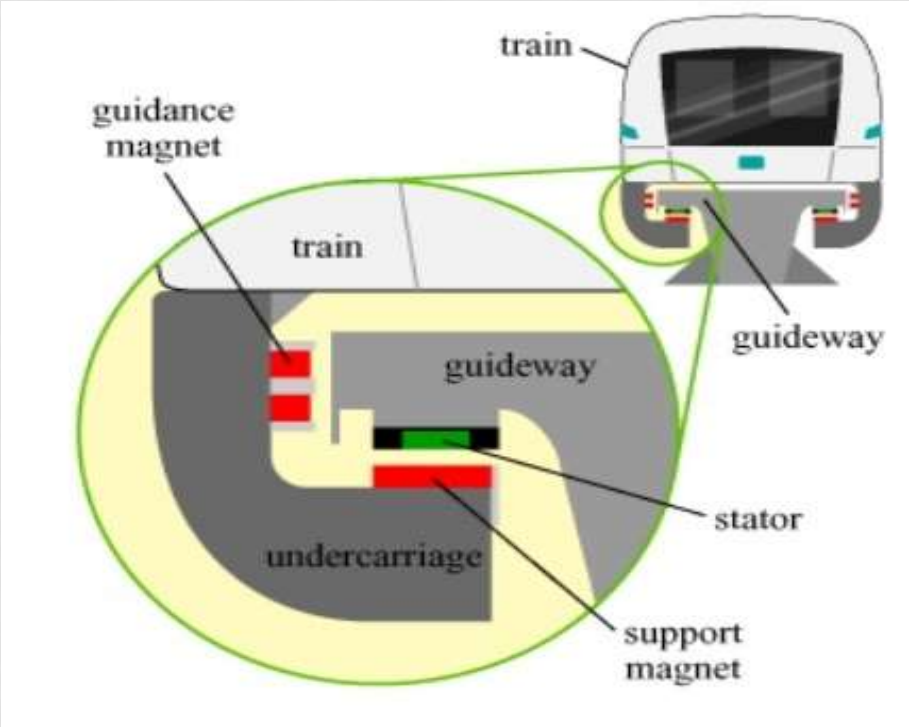
LEVITATION

- The passing of the magnets/magnetic coil through levitation coils on the track induces a current in the coils and creates a magnetic field. This pushes the train upward so that it can levitate above the track.



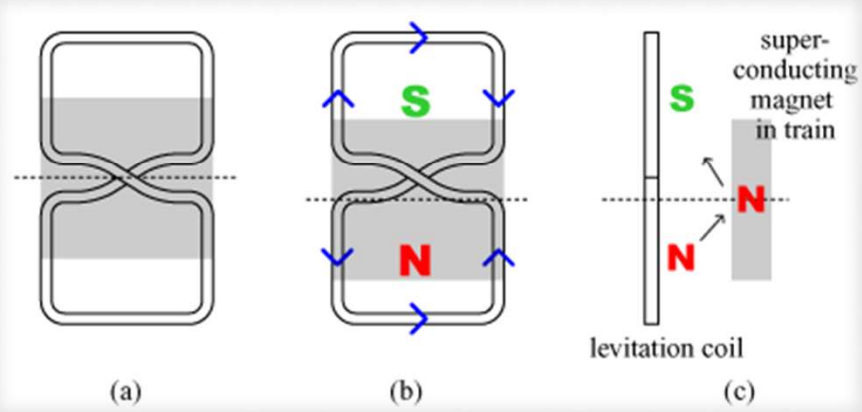
EMS LEVITATION

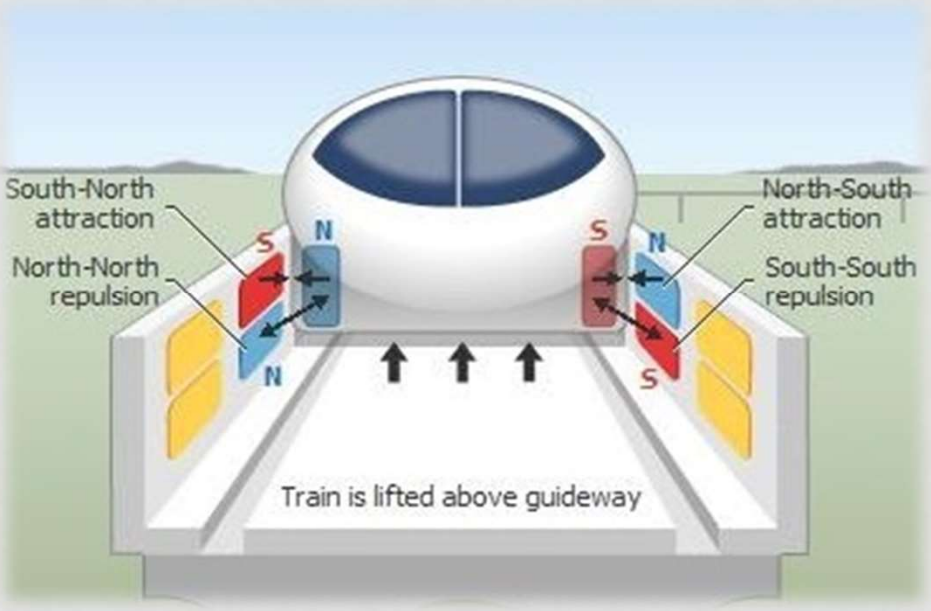
- **Levitation may takes place by attraction.** Attraction is caused by currents within each of the circuits traveling in the same direction. This attractive force is created between the train and the track.



EDS LEVITATION

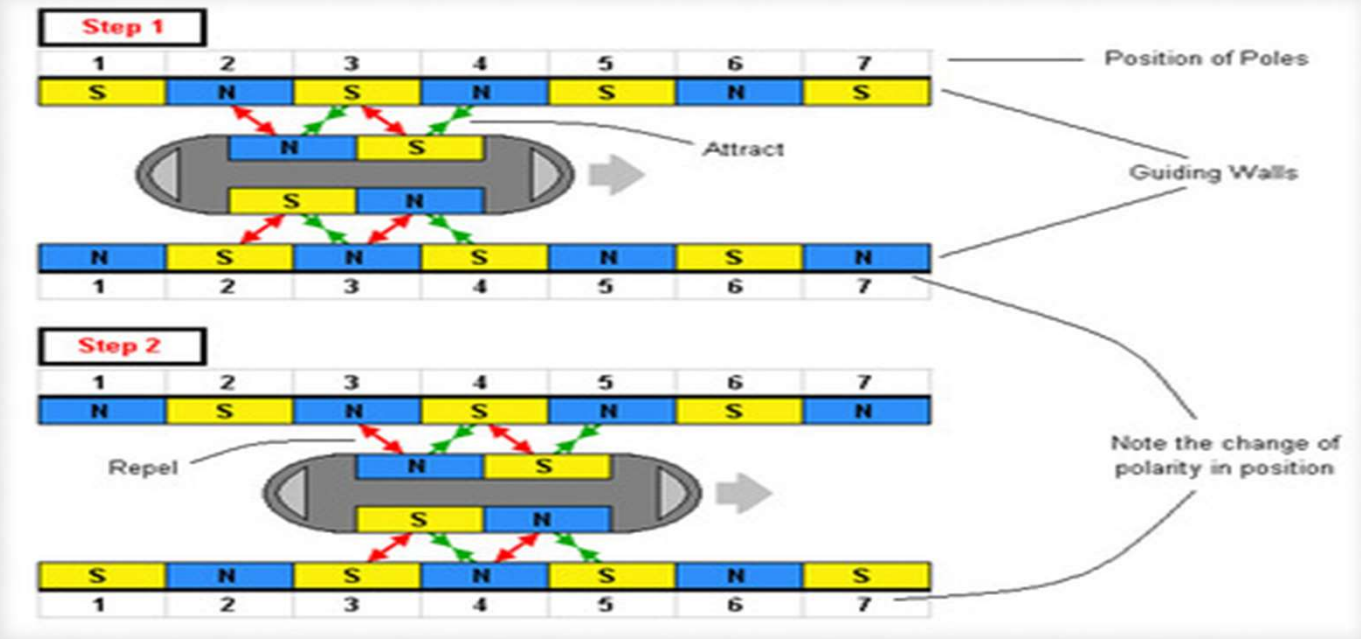
- **Levitation may takes place by repulsion.** The current in the top circuit travels in the opposite direction of the current in the bottom; resulting in a repulsion between two coils.
- The train does not levitate until it reaches 50 mph, so it is equipped with retractable wheels.





PROPULSION

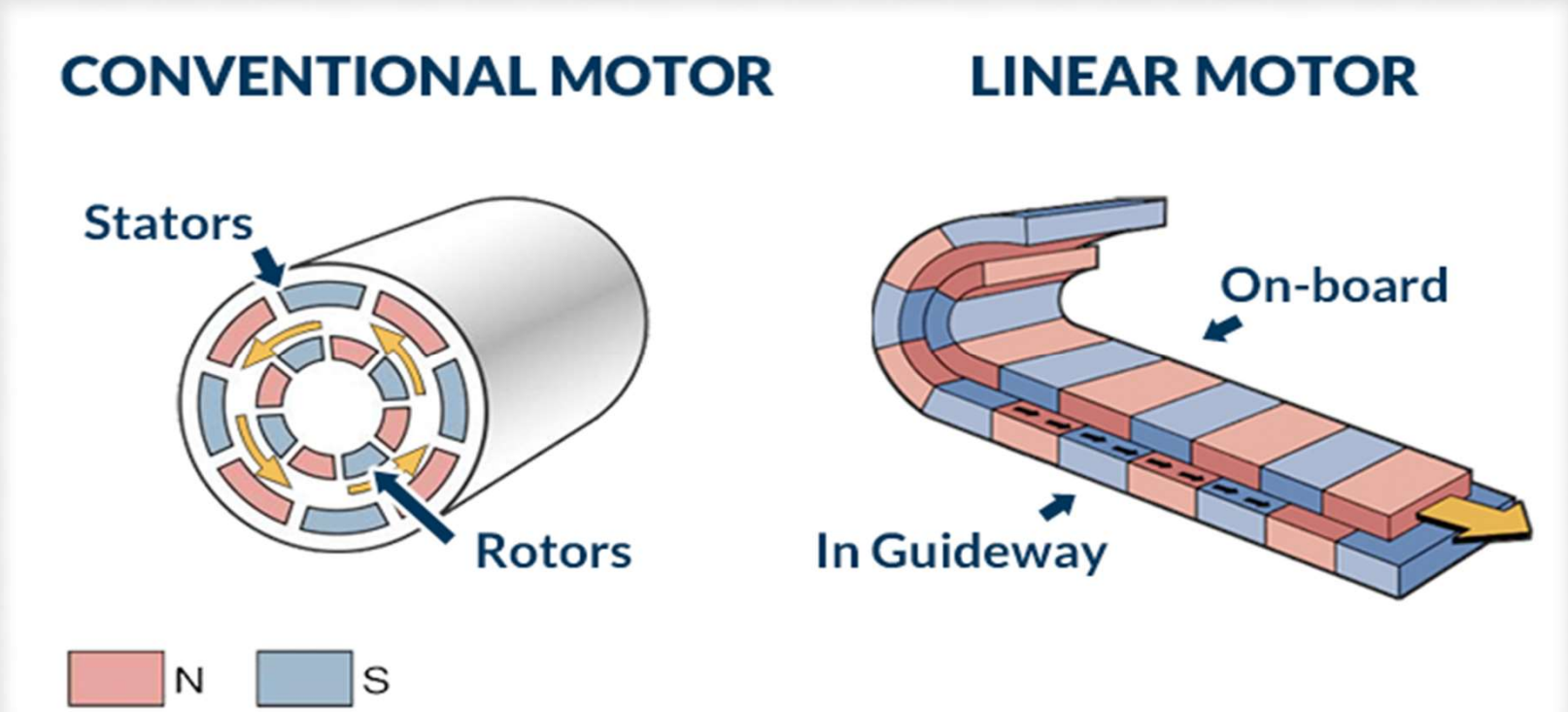
- An alternating current is ran through electromagnet coils on the guide walls of the guide way. This creates a magnetic field that attracts and repels the superconducting magnets on the train and propels the train forward.



EMS PROPULSION

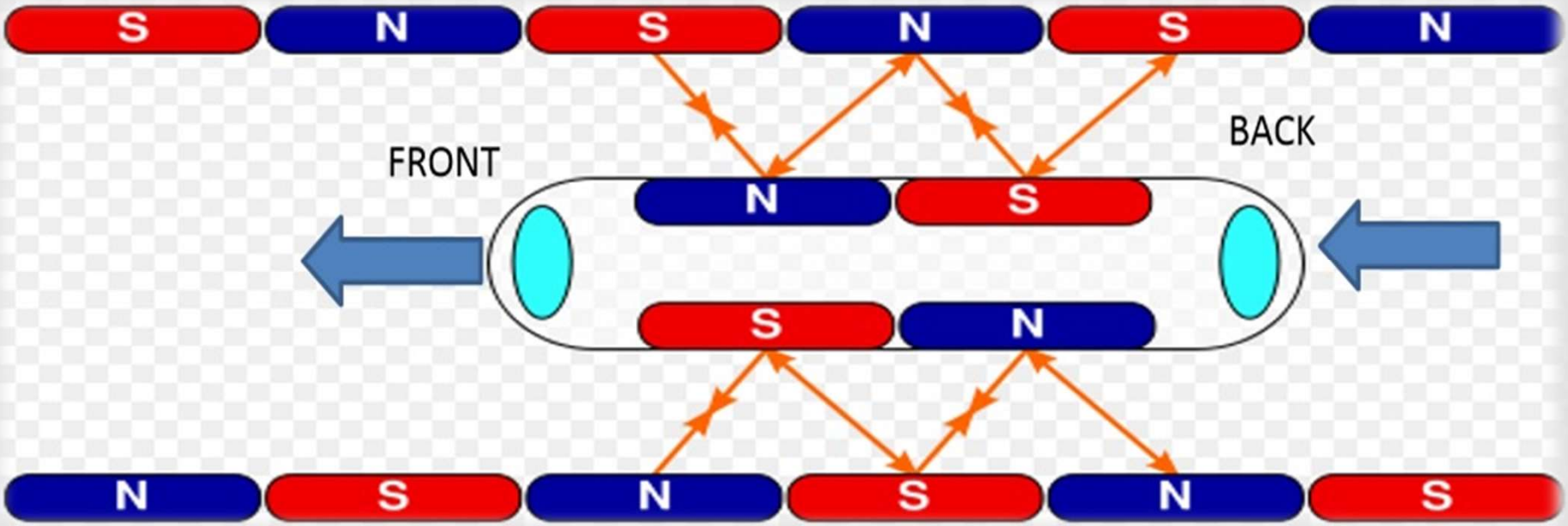
- The propulsion of the train is mainly based on–

  Linear Electric Motor (LEM)



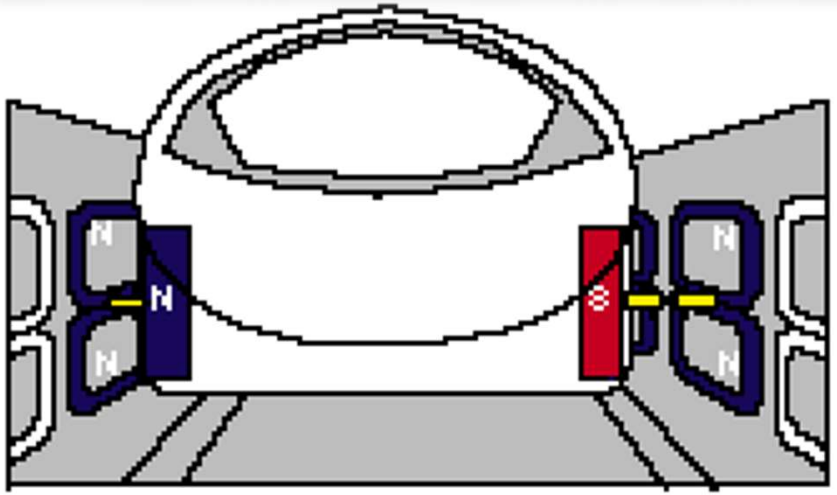
EDS PROPULSION

- The propulsion coils located on the sidewalls on both side of the guide way are energized by a three-phase alternating current from a substation, creating a shifting magnetic field on the guide way.



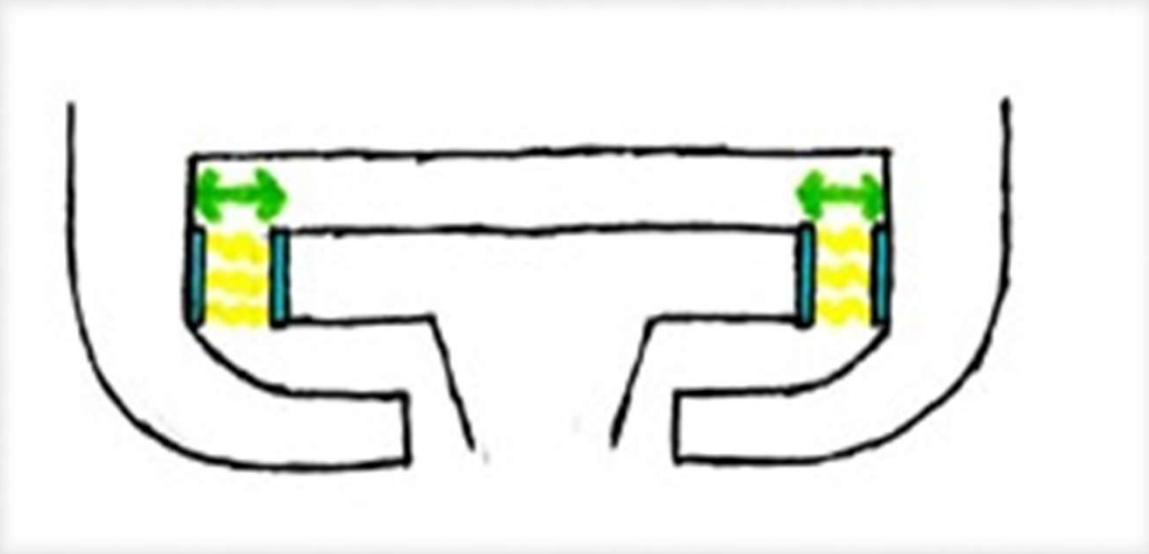
LATERAL GUIDANCE

- When one side of the train nears the side of the guide way, the super conducting magnet on the train induces a repulsive force from the levitation coils on the side closer to the train and an attractive force from the coils on the farther side.
- This keeps the train in the center.



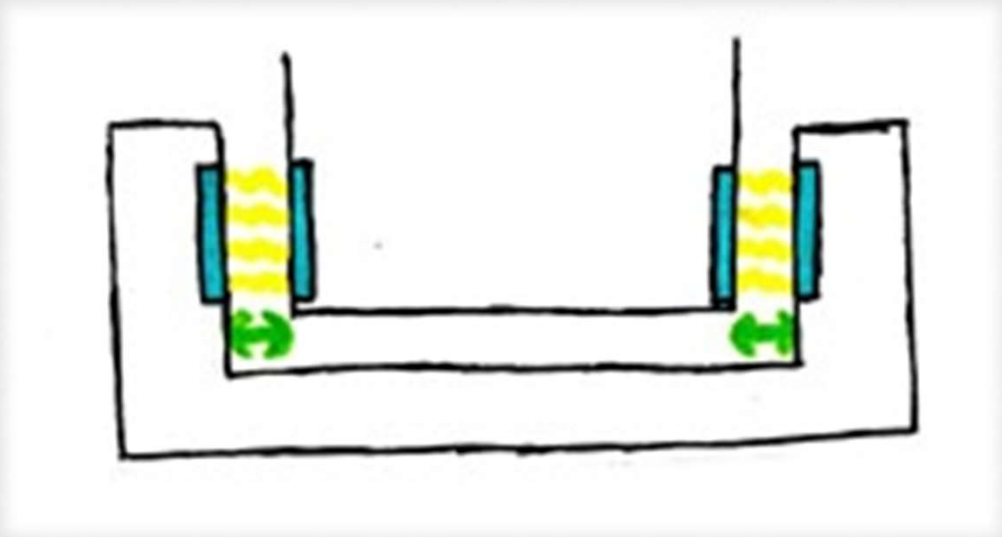
EMS LATERAL GUIDANCE

- The levitation magnets and rail are both U shaped. The mouths of U face one another.



EDS LATERAL GUIDANCE

- In EDS when the vehicle is in straight line , no current flows, When it moves off the line this creates changing flux, generating a field that pushes and pulls it back to the line.
- This mainly keeps the train in center.

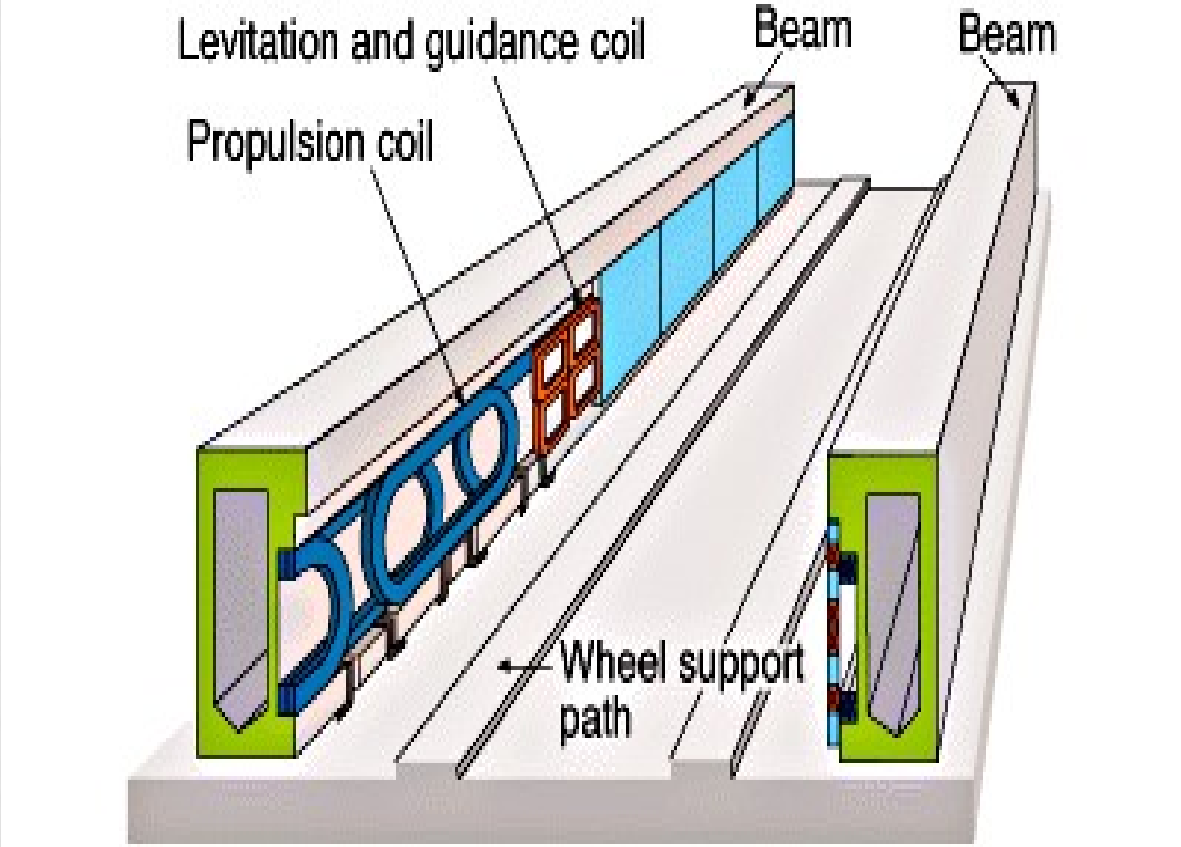


TECHNOLOGY

- Uses magnets to reach a really high velocity.
- Floats about 1-10cm above the guide way on a magnetic field.
- Propelled by the guide way.
- Once the train is pulled into the next section the magnetism switches so that the train is pulled on again.

MAGLEV TRACK (EDS)

- Beam
- Levitation coil
- Guidance coil
- Propulsion coil

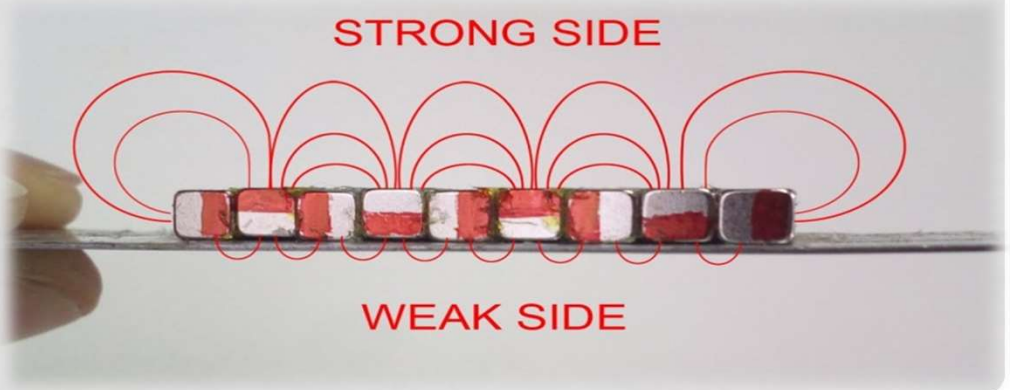


BRAKING AND SPEED CONTROL

- The Maglev's speed can vary from standstill to full operating speed by simply adjusting the frequency of the alternating current.
- To bring the train to a full stop, the direction of the travelling field is reversed.

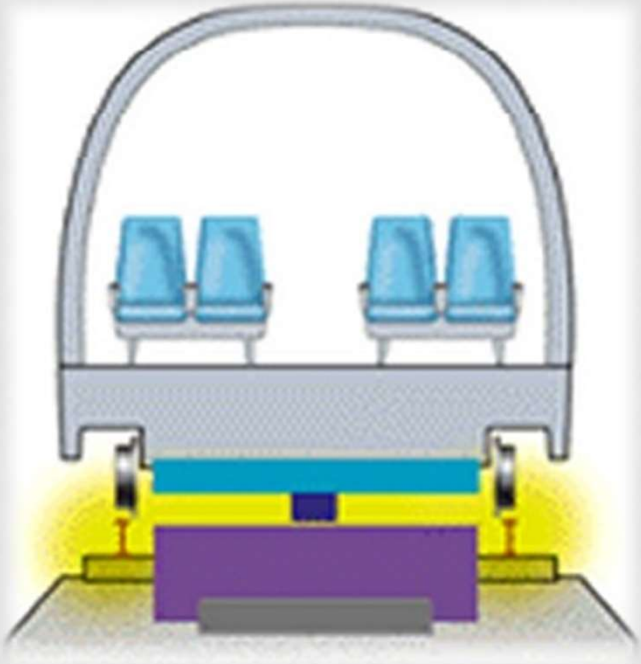
INDUCTRACK

- The Inductrack is a newer type of EDS that uses permanent room-temperature magnets to produce the magnetic fields instead of powered electromagnets or cooled superconducting magnets.
- Inductrack uses a power source to accelerate the train only until it begins to levitate.
- Arranging the magnets in a **Halbach array.**
- The passive magnetic levitation concept is a core feature of proposed hyperloop transportation systems.
- If the power fails, the train can slow down gradually and stop on its auxiliary wheels.



INDUCTRACK

- There are three Inductrack designs:
  - Inductrack I - for high speeds
  - Inductrack II - for slow speeds
  - Inductrack III - for very heavy cargo loads moved at slow speeds



COMPARISON BETWEEN EMS & EDS

		EMS	EDS
1.	Origin	Germany	Japan
2.	Example	Shanghai Transrapid	Chuo Shinkanshen
3.	Cost (Infrastructure)	£52M/Mile	£210M/Mile (Estimated)
4.	Max. Operational Speed	430 km/h	505 Km/h
5.	Max. Experimental Speed	501 Km/h	605 Km/h
6.	Motor	Linear Synchronous Motor (LSM)	Liner Induction Motor (LIM)
7.	Levitation Height	15 Cm	10 Cm
8.	Wheels For Low Speeds	No Wheels Needed	Wheels Needed (Up To 100 Km/h)
9.	Passengers	574	816

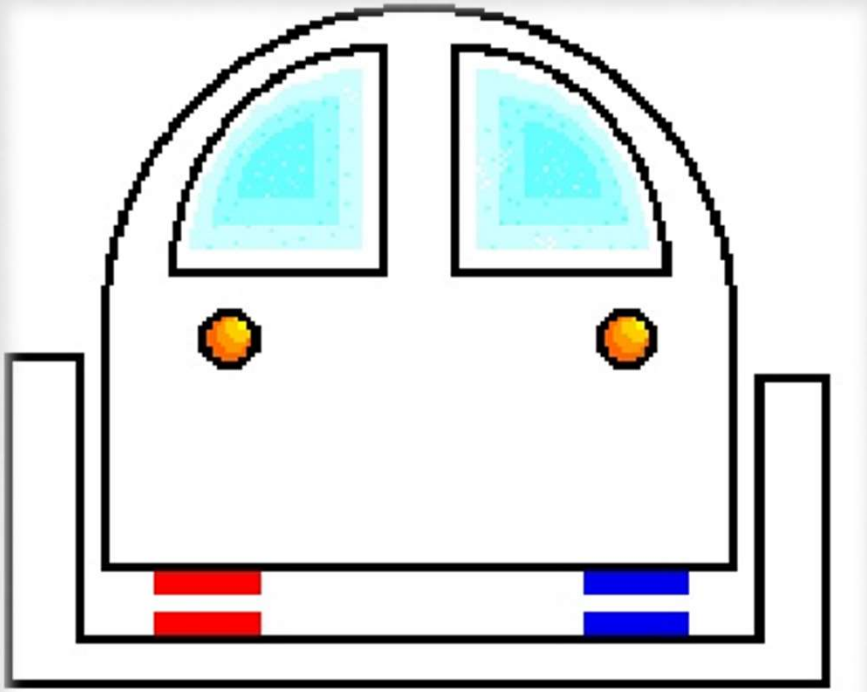
BENEFITS

- Reduce need for additional highways in major urban areas.
- Uses 30% less energy than conventional rail systems.
- They do not have an engine.
- Fast
- Quiet
- Easy maintenance
- Environmentally friendly – No emission

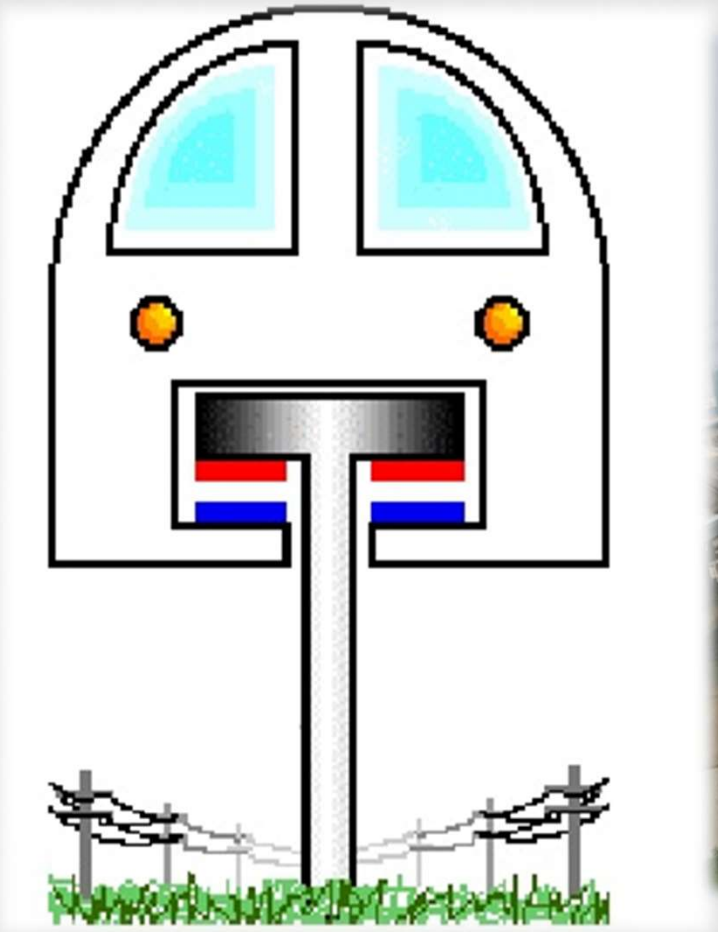
EXAMPLES

Lines	Country	Name	System	Track Length (Miles)	Max. Operational Speed
In Operation	Japan	Linimo	EMS	5.6	100 Km/h
	South Korea	Incheon Airport Maglev	EMS	3.8	110 Km/h
	China	Shanghai Transrapid	EMS	19	431 Km/h
In Construction	Japan	Chuo Shinkanshen	EDS	178	505 Km/h
Test Tracks	Japan	Yamanashi	EDS	26.6	505 Km/h
Lines Planned	Several Countries				

JAPAN MAGLEV



GERMAN MAGLEV



MAGLEV INTERIOR

Shanghai Maglev Driver Cabin

Shanghai Maglev Economy Seats

Shanghai Maglev
VIP Seats


Thank you