Maglev Train for Better Transportation System

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Introduction

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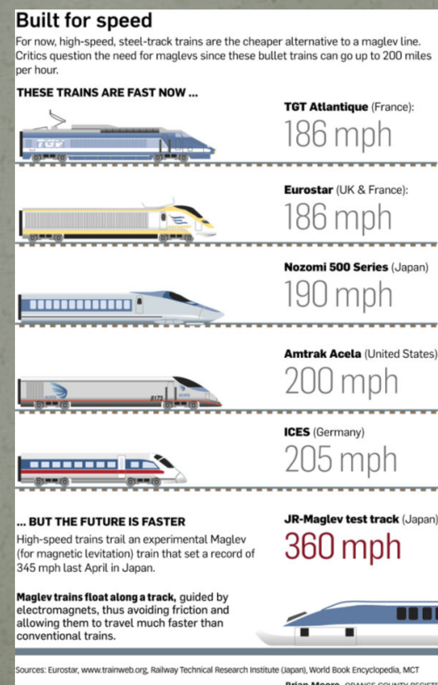
Problem Statement

- The current transportation system is too congested between Washington DC and New York.
  - Car transportation is heavily congested on highways and prolongs traffic delay to 2-3 hours.
  - Airplanes are only efficient for far distance travel not short to medium distance travel.
  - Current train system takes too long for medium distance travel and train transportation is also expensive.

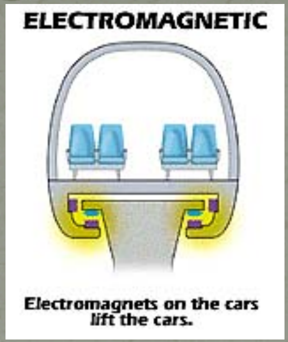
Proposed Solution

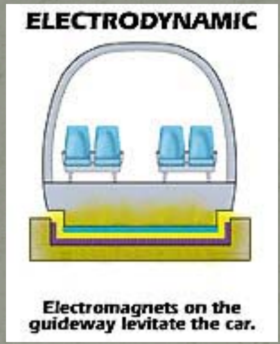
- Maglev Trains
- They are faster than conventional train that exist in the U.S. today.
  - Amtrak Acela takes 3 hours to get from Washington DC to New York (225 mi).
  - Compared to the Chinese Maglev train, travel from Washington to New York could potentially be reduced to 1 hour.
- Maglev's are friction free (float on air), so lower maintenance cost and they produces less noise than steel wheel trains.

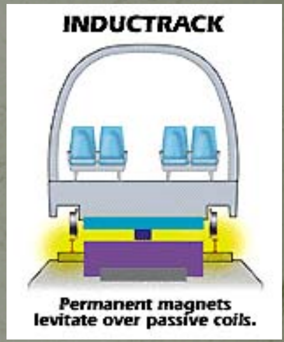


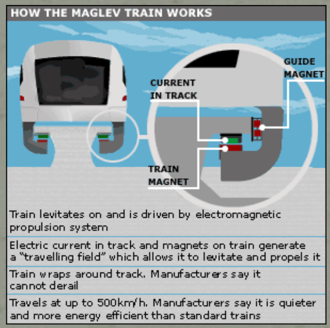
Description of Maglev Train

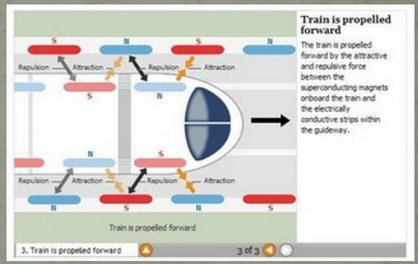
- Magnetic levitation train
- Uses magnetic force to levitate, propel, and guide the train along the guideway.
- Two different types of levitation systems:
  - EMS system
  - EDS system
- Two types of propulsion systems:
  - Linear Induction Motor
  - Linear Synchronous Motor
- Three types of guideways:
  - Beam
  - Panel
  - Direct-attaching



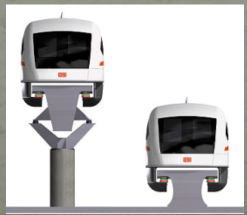




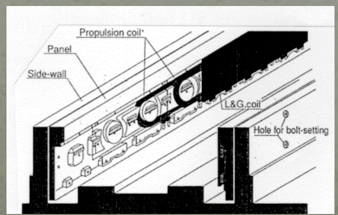




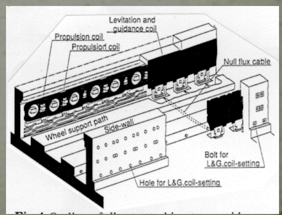
Beam



Panel



Direct



Existing Concerns

- Cost
  - Florida Maglev project between Tampa and Orlando was rejected because of poor planning and the issue of "cost" (estimated $2.3 billion).
  - California-Nevada Interstate Maglev (from Anaheim to Las Vegas, 269 miles)project lost support due to failure to raise required funds (estimated $12 billion).
  - Proposed Maglev project between Baltimore and Washington was estimated to cost $4.9 billion (39.8 miles/64.1 km).
- Chart is example of cost estimate for Baltimore-Washington Maglev Project.

Description	Cost (thousands)
Vehicles	$244,868
Propulsion System	$487,086
Energy Supply (ES)	$47,350
Operation Control System	$97,659
Infrastructure Control System	$4,270
Guideway Infrastructure	$1,694,553
Stations	$396,082
Operations & Maintenance Facilities	$68,430
Corridor Infrastructure	$126,494
Subtotal Construction & Procurement Costs	$3,166,792
Right of Way	$92,000
Management	$482,400
Total Construction	$3,741,192

Project Goal

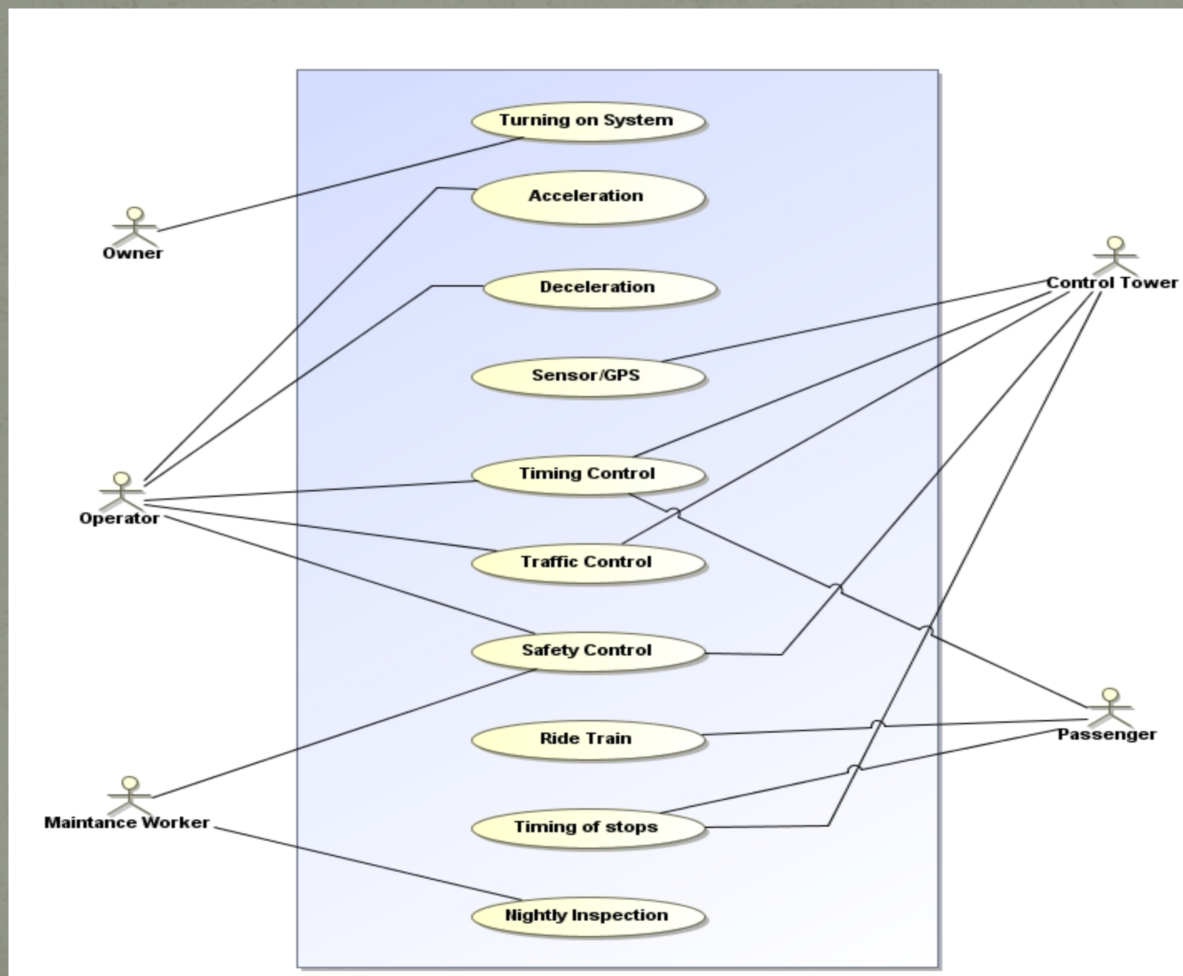
- Our goal is to perform trade off analysis on the speed of the Maglev train with respect to the trains overall cost.
- Components that could be analyzed:
  - Propulsion system
  - Levitation system
  - Number and Location of Stations
  - Guideway Type

High and Low Level Requirements

#	High Requirement Description
1	Train must levitate
2	Train must accelerate and decelerate
3	Must be able to stop
4	Train must stay on the track/guideway
5	Train must hold passengers
6	Guideway must be sturdy enough to hold train
7	Permanent/Electro-magnets must keep train propelled above the track

#	Low Requirement Description
1	Top speed must be higher than 150 mph
2	Capacity of the train car must be at least 125 passengers
3	Make at least 5 major stops at Maglev stations
4	Have track and guideway be located at least 100 m from buildings
5	Must travel from DC to New York in under an hour
6	Must operate in all weather conditions
7	Must have emergency procedure for problems with train/track/or overall system
8	Each train car can weight no more than 50 tons
9	Guideway must be at least 225 miles long (362km) to get from DC to New York

Use Cases


Turning on System
Acceleration
Deceleration
Sensor/GPS
Timing Control
Traffic Control
Safety Control
Ride Train
Timing of stops
Nightly Inspection
Owner
Operator
Maintance Worker
Control Tower
Passenger

Textual Scenario: Acceleration Case

Description: Process of speeding up using the electromagnets

Primary Actor: Operator

Pre-conditions: Device to control electromagnetic polarity to push-pull train to speed up

Flow of events:

a. Operator accelerates train through some action

b. Make sure acceleration is at a slow constant (i.e. decrease jerk)

c. Acceleration stops when desired speed is achieved

Post-Conditions: Train will continue running at desired speed

Textual Scenario: Timing Control Case

Description: Keeping track of train arrival/departure times for all trains

Primary Actor: Control Tower

Pre-conditions: GPS to track train location and speed

Flow of events:

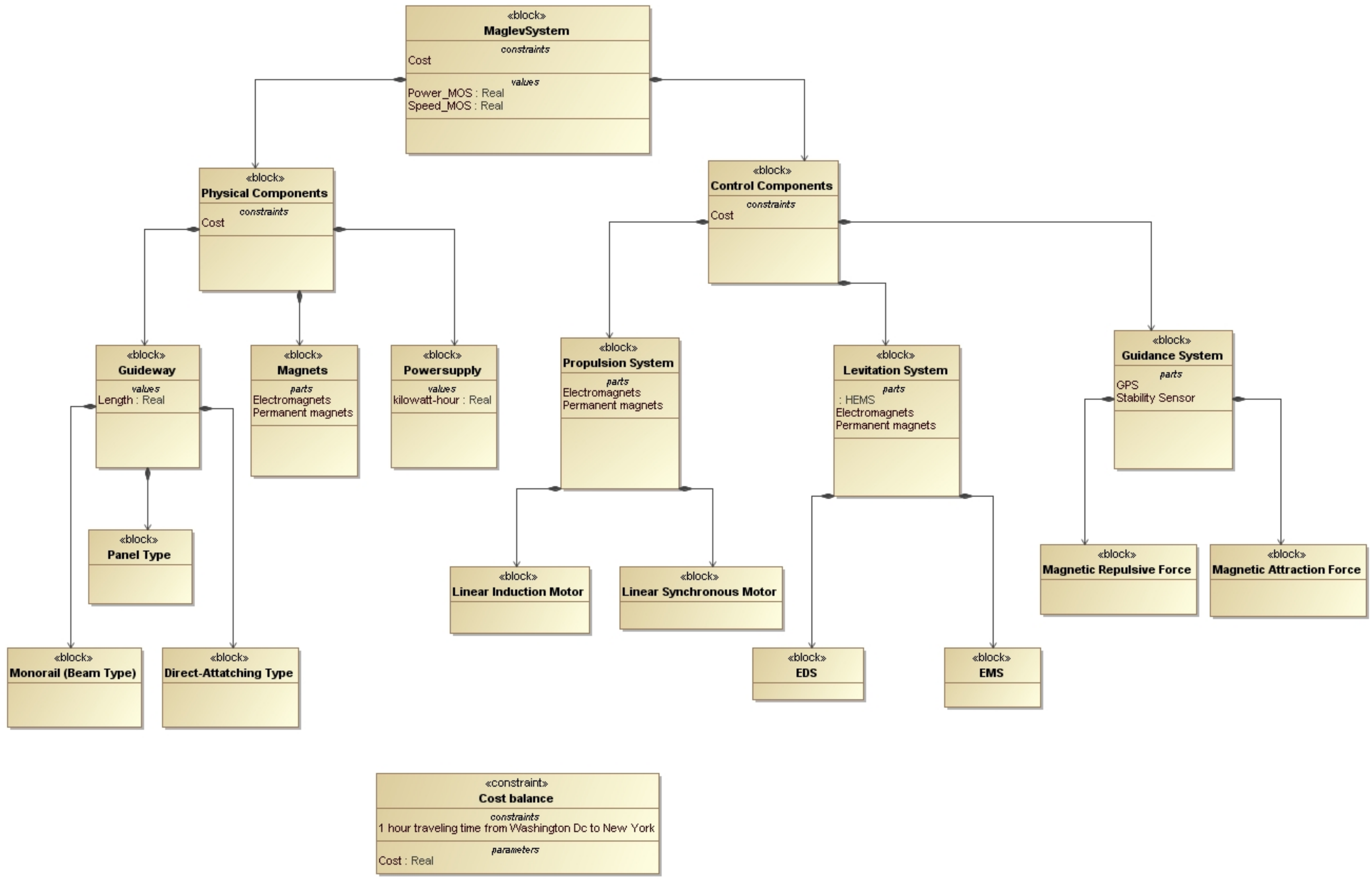
a. Train GPS signal is sent to control tower

b. Control tower uses distance and speed to calculate arrival time

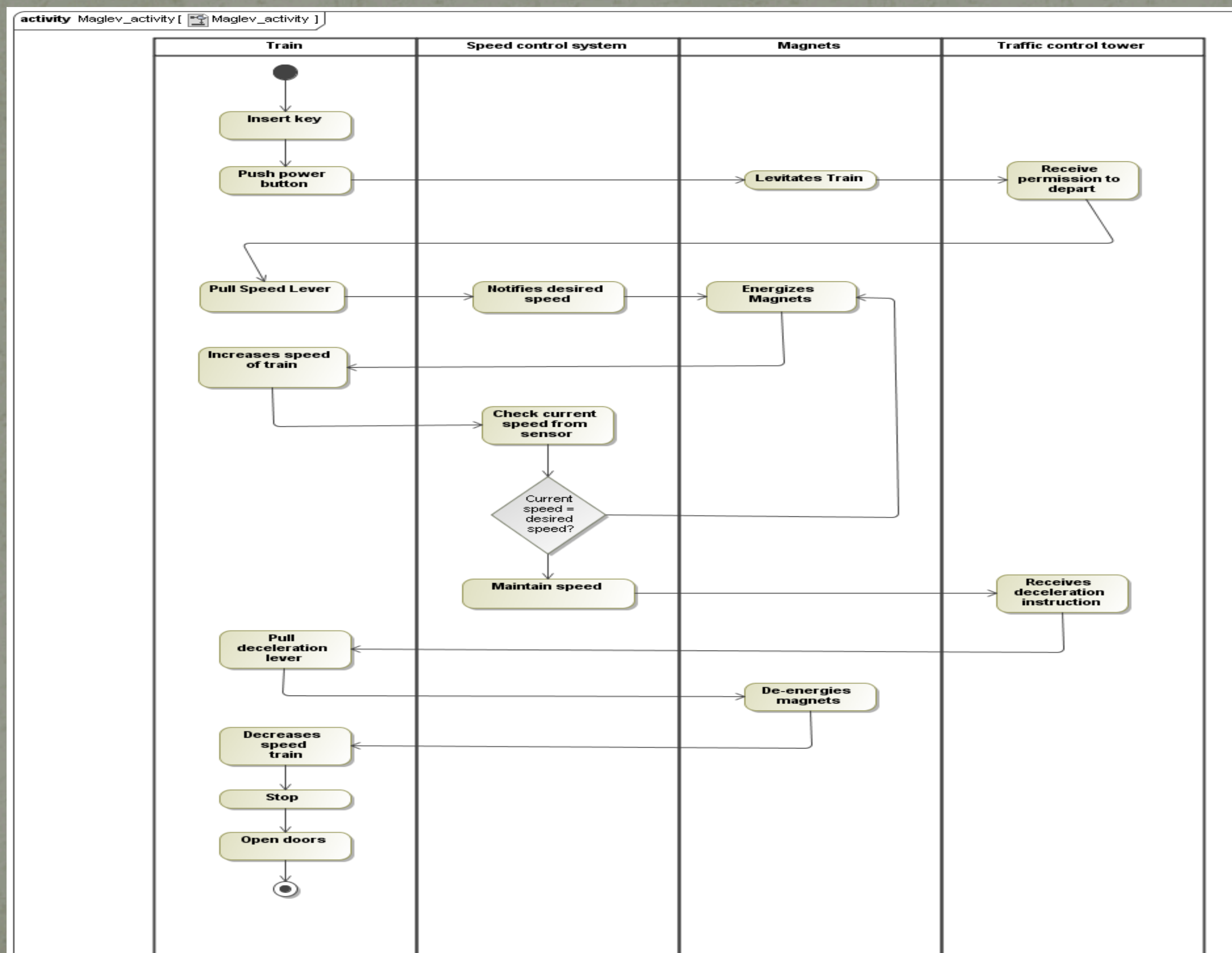
c. If there is any cause for delay, train will have to notify control tower so that it can change the schedule accordingly

Post-Conditions: Trains will arrive/depart on schedule

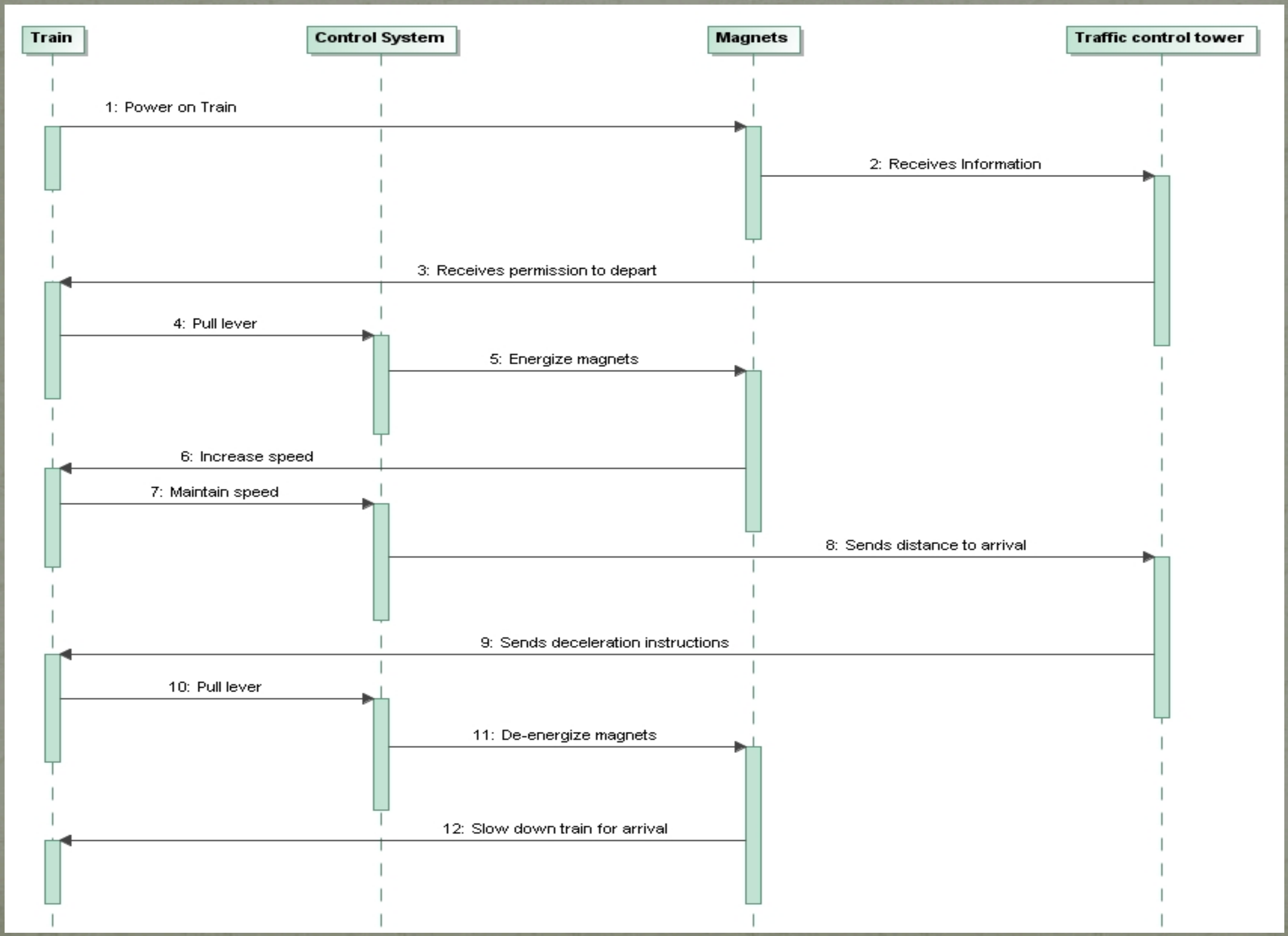
Structure Diagram



Activity Diagram



Sequence Diagram



Tradeoff Options

We would like to analyze several different scenarios comparing the levitation system, propulsion system, guideway type, and number of stops.

- EDS, LIM, MAF, 3
- EDS, LIM, MAF, 6
- EDS, LIM, MAF, 9
- EDS, LIM MRF, 3
- EDS, LIM, MRF, 6
- EDS, LIM, MRF, 9
- EDS, LSM, MAF, 3
- EDS, LSM, MAF, 6
- EDS, LSM, MAF, 9
- EDS, LSM, MRF, 3
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- EDS, LSM, MRF, 9
- EMS, LIM, MAF, 3
- EMS, LIM, MAF, 6
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- EMS, LIM MRF, 3
- EMS, LIM, MRF, 6
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- EMS, LSM, MAF, 3
- EMS, LSM, MAF, 6
- EMS, LSM, MAF, 9
- EMS, LSM, MRF, 3
- EMS, LSM, MRF, 6
- EMS, LSM, MRF, 9

Conclusion

- After preliminary analysis of the Maglev system the next step is to further assess the components and work on trade-off analysis.

- The benefits of the Maglev train overall outweigh the problems.

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