

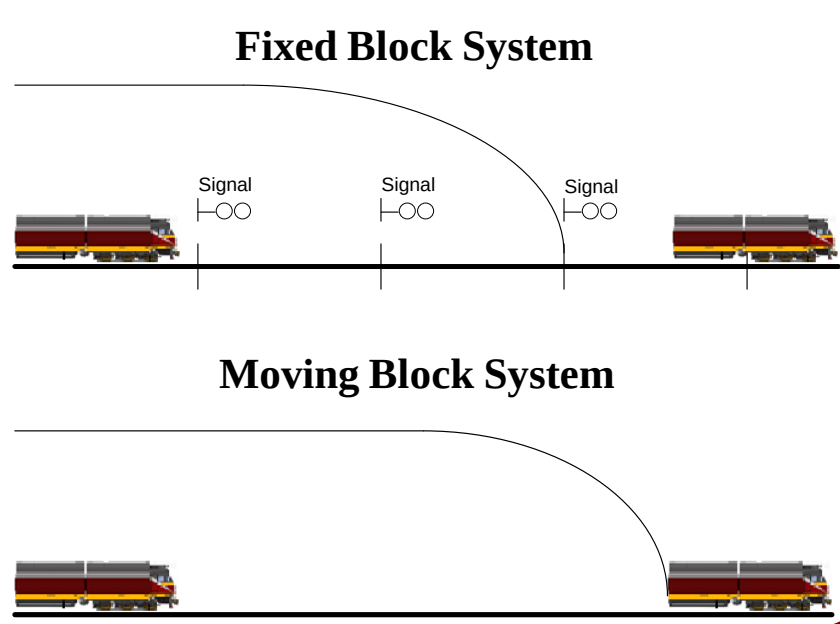
Dynamic Train Headway Selection and Its Effect on Capacity

Yanbo Zhao

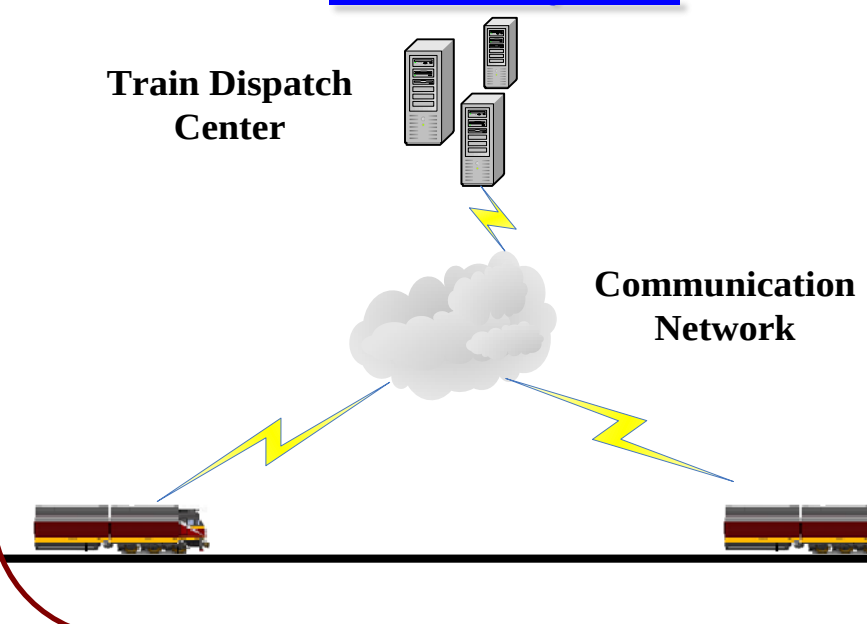
Petros Ioannou

Motivation & Introduction

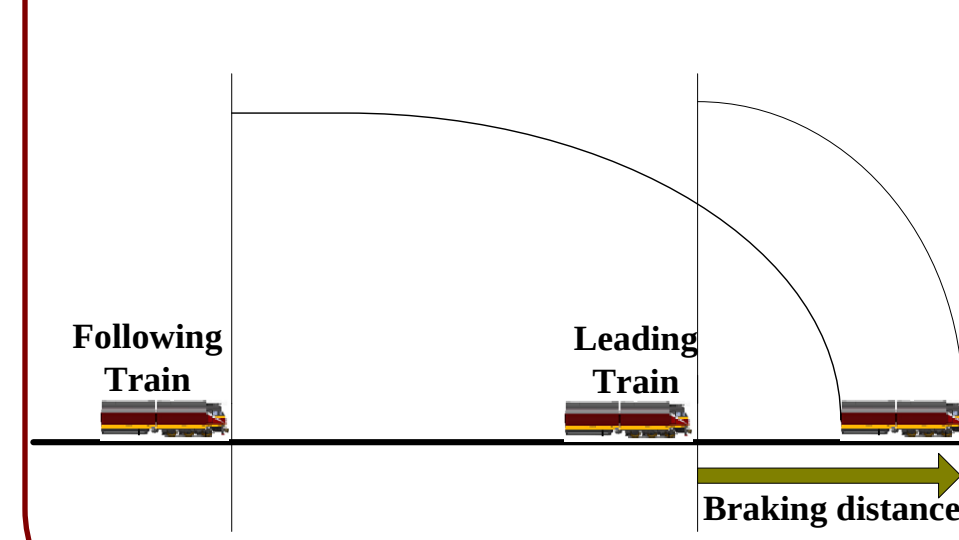
Brick-wall Headway Policy



Communication Based Train Control System



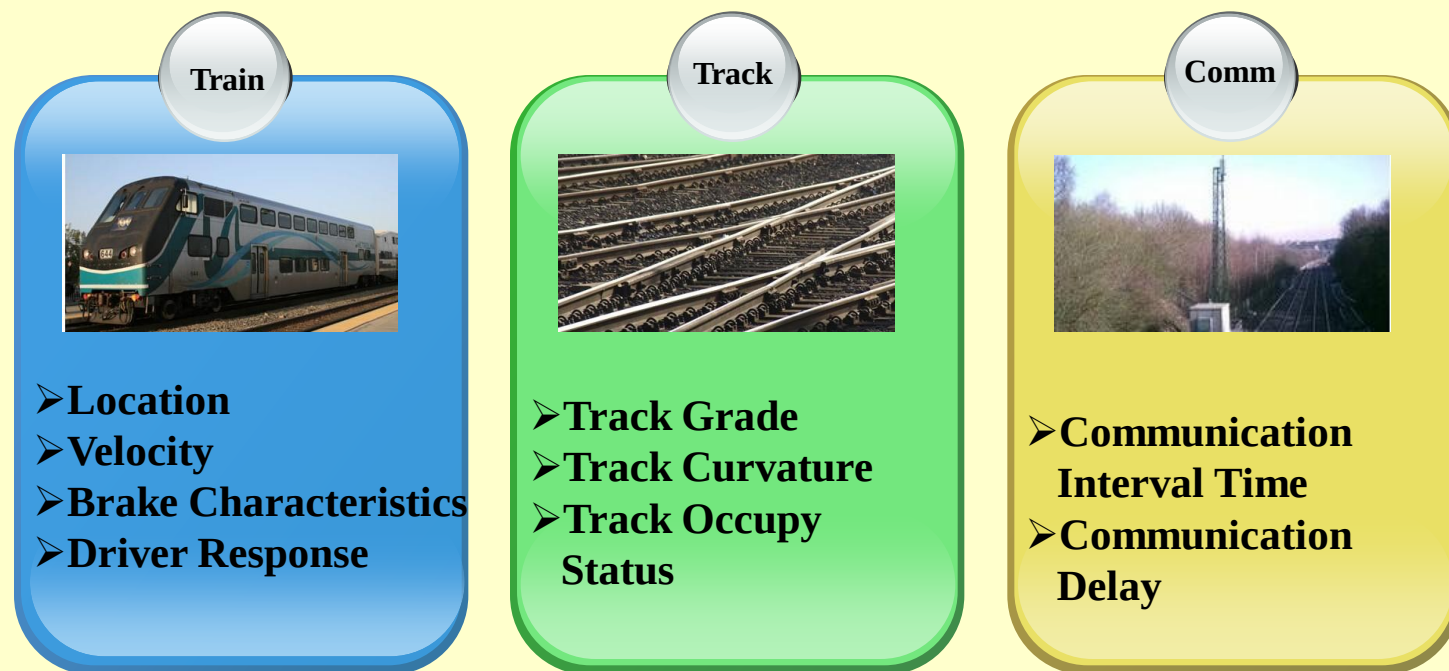
Dynamic Headway Policy



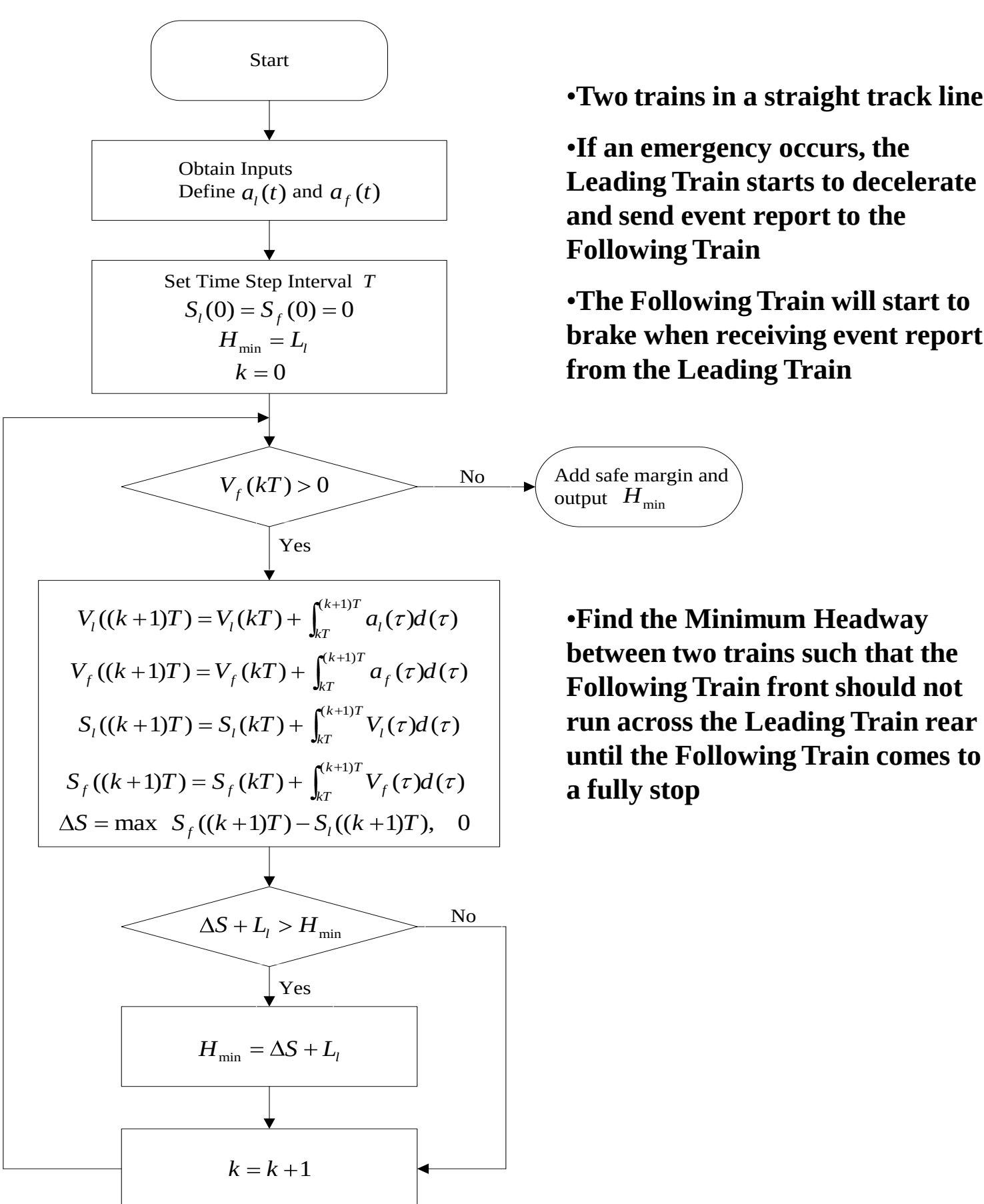
- Communication Based
- Continuous Updating
- Reducing Headway
- Improving Capacity

Proposed Method

Input Factors



Numeric Headway Calculation Algorithm



Failure Tolerance Headway Selection

$$H = \max \{H_{min}, \text{Following Train Emergency Stopping Distance} + \text{Leading Train Length}\}$$

Evaluation & Results

Input Parameters

	Passenger Train	Freight Train
Length, feet	250	3000
Maximum Service Brake Rate (feet/min ²)	5280	1950
Maximum Emergency Brake Rate (feet/min ²)	10560	3900
Brake System Response Time (sec)	0.5	0.5
Brake System Build-up Time (sec)	2.0	2.0
Velocity (mph)	60	40
Driver Reaction Time (sec)	0.5	0.5
Communication Delay (sec)	1	
Track Grade	0	
Track Curvature Radius (feet)	0	
Safe Margin Distance (feet)	200	
Time Interval in Timetable Headway Policy (min)	5	

Headways of Different Policies

	Timetable Policy (5 min)	Brick-wall Policy	Dynamic Policy
Case 1 P-P	26550 ft	3286 ft	1858 ft
Case 2 P-F	20600 ft	3758 ft	3410 ft
Case 3 F-P	29300 ft	6036 ft	4376 ft
Case 4 F-F	23600 ft	6508 ft	4847 ft

Sensitivity Analysis (Case F-F)

Factor	Value	Headway (ft)	Line Capacity (trains/hour)
Initial Velocity (mph)	20	3627	29.1
	30	4138	38.3
	40	4847	43.6
	50	5755	45.0
	60	6862	46.2
Service/Emergency Brake Capability (feet/min ²)	975/1950	6436	32.8
	1560/3120	5244	40.2
	1950/3900	4847	43.6
	2340/4680	4583	46.1
	2925/5850	4318	48.9
Driver Reaction Time Difference (sec)	-2	4730	44.7
	-1	4788	44.1
	0	4847	43.6
	1	4906	43.1
	2	4965	42.5
Track Grade	-3‰	5403	39.1
	-2‰	5189	40.7
	-1‰	5005	42.1
	0	4847	43.6
	+1‰	4710	44.8
	+2‰	4589	46.0
	+3‰	4482	47.1
Communication Delay (sec)	0	4789	44.1
	0.4	4800	43.9
	0.8	4824	43.7
	1.0	4847	43.6
	1.2	4859	43.4
	1.6	4870	43.2
	2.0	4905	43.0

Headway Policy Switch

Dynamic Headway Policy to Brick-wall Policy when Communication Network Fails

- Decelerate Trains to New Operation Velocity
- Check The Received Signal

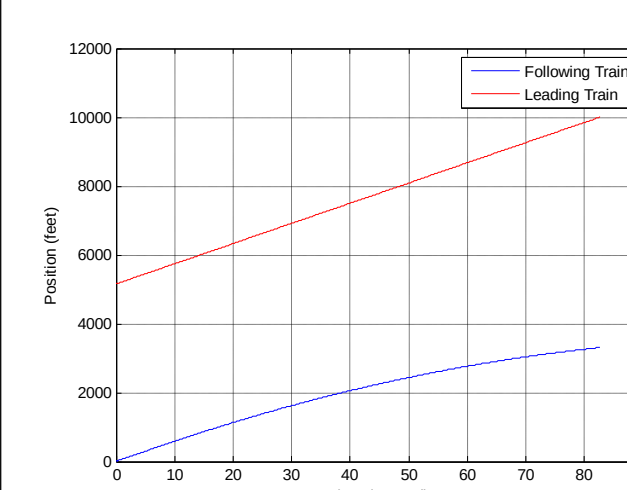
If Green, Switch Successfully

If Not, Continue Deceleration

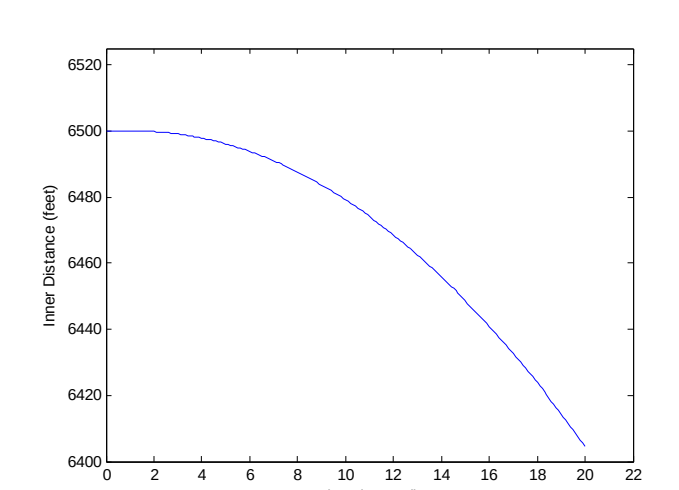
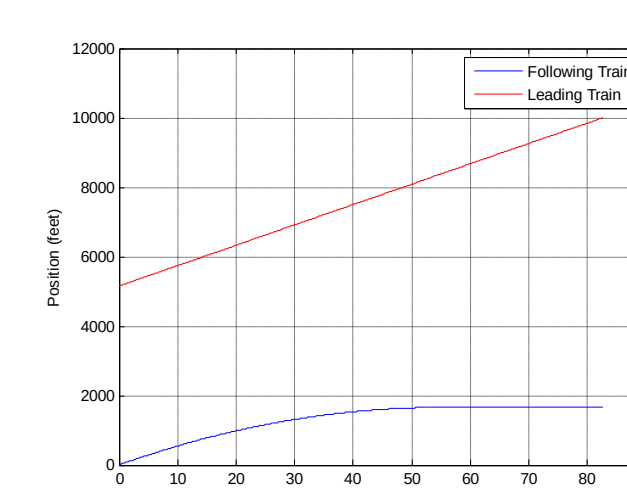
Brick-wall Policy to Dynamic Headway Policy when Communication Network Recovers

- Accelerate Trains to Reduce Inner Distance until Reaching Minimum Secure Dynamic Headway

Examples



Switch to Brick-wall Policy



Switch to Dynamic Policy