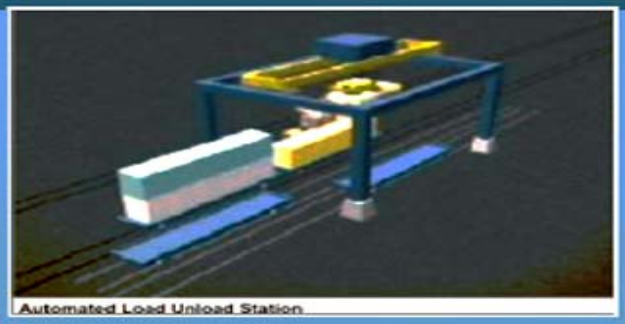
3rd METRANS National Urban Freight Conference

October, 2009 Long Beach, CA

Magnetic Levitation

Exclusive Contact Guideway



Electric/Battery Powered Trucks

Presented by:
D. Sanford Stadtfeld, URS Corporation

In Association with: Jerry R. Wood, P.E. Director of Transportation and Engineering
Gateway Cities Council of Governments

Southeast Los Angeles County, CA Zero Emission Alternative Transportation Technologies

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I-710 Corridor Project EIR/EIS
Alternative Technology Study

- The I-710 Problem
- Zero-Emission Technology Study
- Automated Fixed-Guideway Technologies
- Electric / Battery Truck Technology
- Summary
- What's Next

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The I-710 Problem

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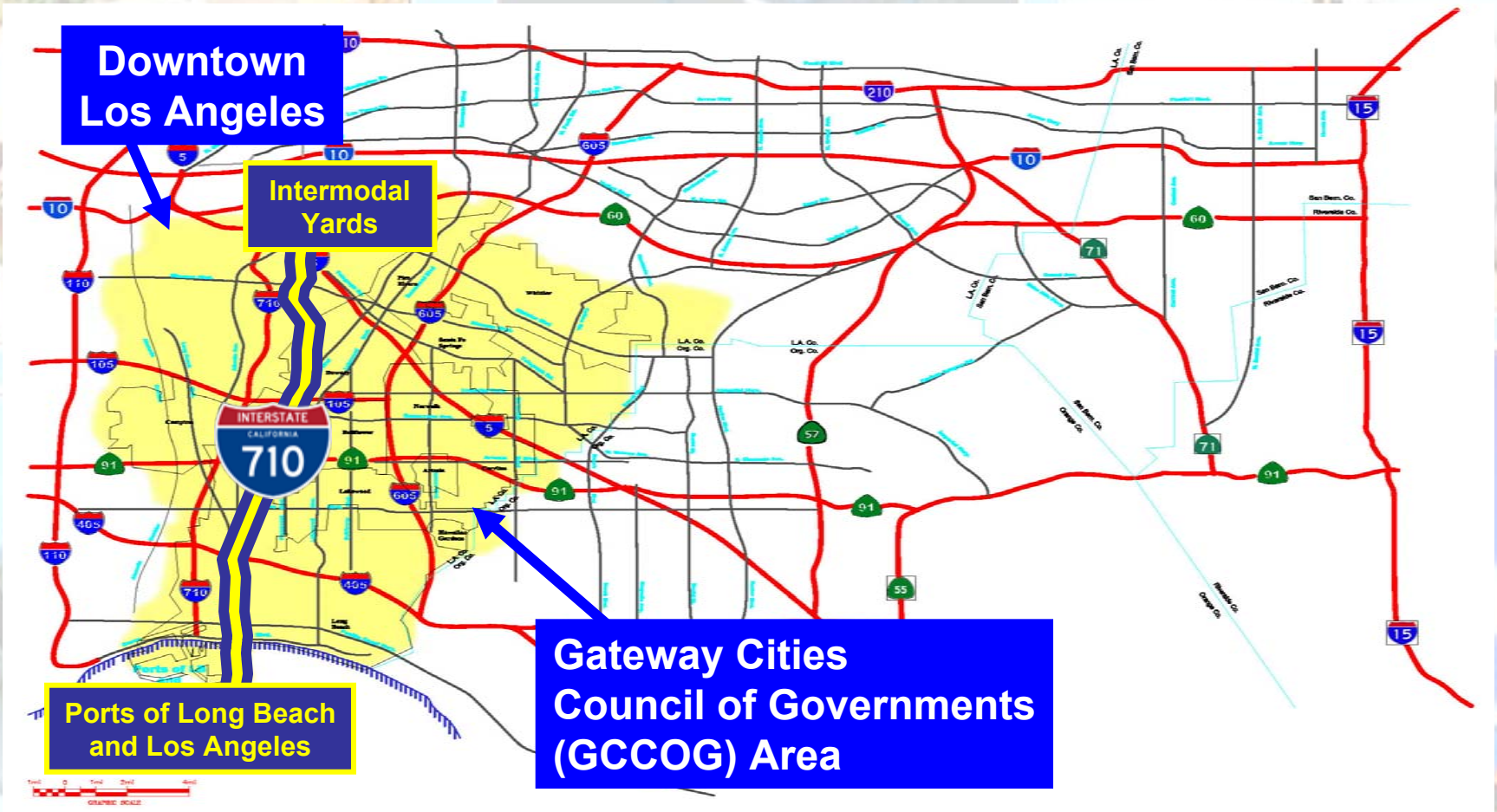

Main Truck Route Between Ports and Off-Dock Intermodal Yards

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Impacts of Port Logistics on GCCOG Communities

- Increase (≈ 200%) in port truck & rail traffic by 2035
- Need for greater intermodal yard capacity
- Need for additional warehouses & distribution centers

Commnity / Environment / Public Health

- *Adverse air quality (especially diesel emissions)*
- *Increased vulnerability to respiratory illness*
- *Increased truck-related accident rate*
- *Community separation*

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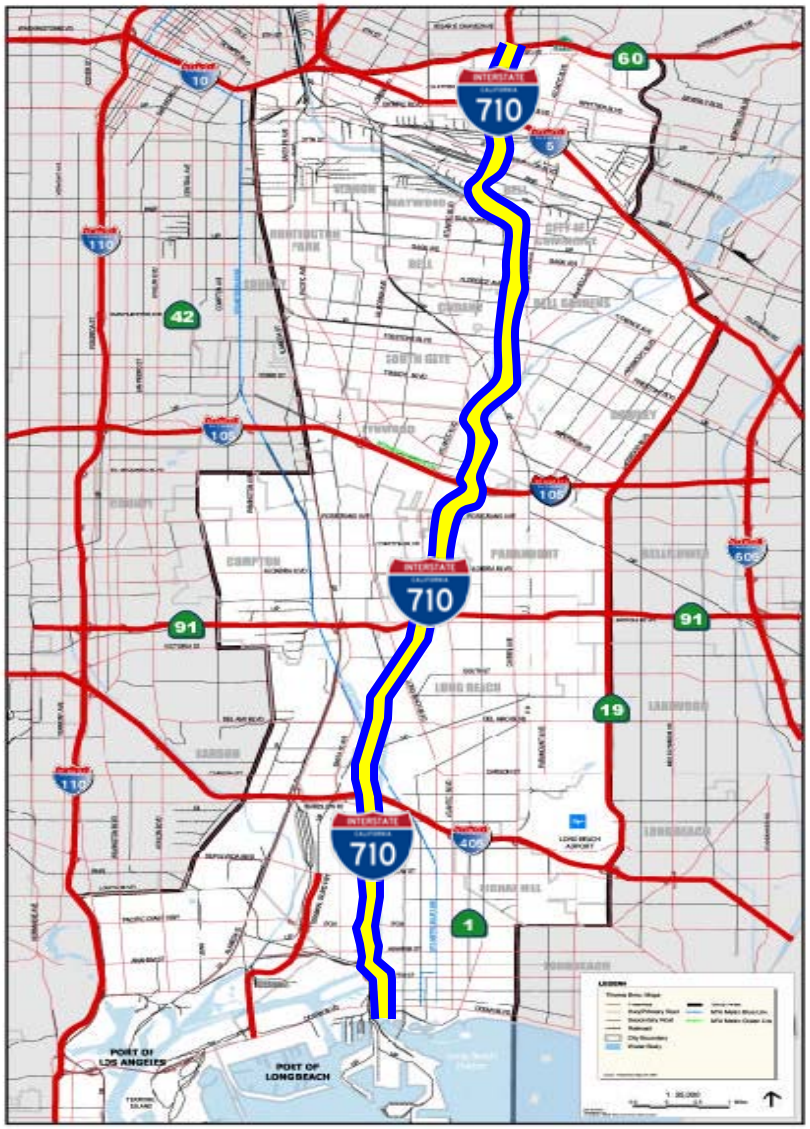

I-710 Freeway Corridor Project EIR/EIS

- Community consensus on a special design to improve the I-710 freeway
- I-710 Project includes a dedicated freight corridor over its entire length

First major U.S. project to analyze zero-emission alternative container transport technology in detail

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Purpose of I-710 Alternative Technology Study

- Evaluate benefits and impacts of technically and commercially feasible technologies
- Identify potential alternative technology alignments
- Define a generalized application of alternative technology
- Develop technology-neutral definition of requirements, parameters, conditions and constraints to be addressed via a holistic approach

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Background: Zero Emission Container Movement System (ZECMS) Study Completed for the Ports in 2007

- **14 technologies** surveyed for responsiveness to Ports' near-dock intermodal service scenarios
- 2 families of **Automated Fixed Guideway** technology emerged as responsive to Port's markets:
  - **Magnetic Levitation (Maglev)**
    Vehicles use magnetic force for levitation and propulsion on an exclusive guideway.
  - **Exclusive Contact Guideway**
    Vehicles physically borne on steel wheels or rubber tires; self-propelled, or are powered by linear induction.

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Potential Automated Fixed Guideway Technologies

Magnetic Levitation

Exclusive Contact Guideway

Automated Load Unload Station

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I-710 EIR/EIS Market Analysis

- An alternative technology could serve **part** of the projected 2035 **near-dock** and **off-dock** intermodal container markets
- An alternative technology could also serve **parts of other geographic markets**
- The on-dock market will continue to be served by rail
- An alternative technology in the I-710 Corridor could be considered an initial segment of a **regional network**

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Annual market that could be served by a new technology was estimated for 3 future scenarios:

Scenario	Off Dock and Near Dock		East of Los Angeles		Total Potential Container Market	
Port No Build no near-dock railyard capacity increase	TEU	40' Cargo Container Equivalents	TEU	40' Cargo Container Equivalents	TEU	40' Cargo Container Equivalents
Total	5.8	3.1	4.5	2.4	10.3	5.5
This scenario assumes no additional rail facilities at the Ports, no construction of additional near-dock railyards						

Port Build no near-dock railyard capacity increase	TEU	40' Cargo Container Equivalents	TEU	40' Cargo Container Equivalents	TEU	40' Cargo Container Equivalents
Total	4.3	2.3	6.8	3.7	11.1	6.0
This scenario assumes additional rail facilities at the Ports but no construction of additional near-dock railyards						

Port Build with near-dock railyard capacity increase	TEU	40' Cargo Container Equivalents	TEU	40' Cargo Container Equivalents	TEU	40' Cargo Container Equivalents
Total	4.3	2.3	6.8	3.7	11.1	6.0
This scenario assumes additional rail facilities at the Ports, construction of additional near-dock railyards						

(all numbers in millions)

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System Capacity is expressed as both terminal capacity and line haul capacity

TERMINAL (PORT/RAILYARD) CAPACITY	LINE HAUL CAPACITY

$$\text{T x 20} = \text{C x F} = \text{Hourly Capacity} = \frac{3{,}600 \text{ Sec/Hr}}{\text{H}} \times \text{G X C}$$

Hourly Capacity: Containers Per Hour

Inputs

T = number of loading/unloading tracks at facility
- 31 tracks "Port Build"
- 37 tracks "Port No Build"

20 = number of lifts per hour per terminal track

C = number of cars per consist or platoon
- 6 cars
- 10 cars
- 12 cars

F = dispatch frequency, in movements per hour

Inputs

H = minimum headway on individual guideway
- 60 seconds
- 90 seconds
- 120 seconds

G = number of line haul guideway tracks in both directions
- 2 tracks
- 4 tracks
- 6 tracks

C = number of cars per consist or platoon
- 6 cars
- 10 cars

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Terminal Capacity Analysis

Operating Schedule	
hours per day	21
days per year	360

Off-Dock / Near-Dock (CSI)	
Port Build	2,330,000
Port No Build	3,130,000

+ East of Los Angeles / Transload (Tioga)	
Port Build	3,658,000
Port No Build	2,443,000
Port Build	**5,988,000**
Port No Build	**5,573,000**

System Variables - Terminal				System Capacity (containers)			Capacity/Demand Market Share		Capacity/Demand Market Share	
T: Number of Station Tracks	Lifts per Hour per Track	C: Cars per Consist	F: Dispatch Frequency (Seconds/Consist)	Hourly Capacity	Daily Capacity	Annual Capacity	% of Port No Build Scenario	% of Port Build Scenario	% of Port No Build Scenario	% of Port Build Scenario
31	20	6	35	**620**	13,020	4,687,200	150%	201%	84%	78%
		10	**58**							
		12	70							
37	**20**	6	29	**740**	**15,540**	**5,594,400**	**179%**	**240%**	**100%**	**93%**
		10	**49**							
		12	58							
Terminal scenarios with more terminal (loading and unloading) tracks, more cars per consist, and more cranes per terminal track										
31	30	10	39	**930**	19,530	7,030,800	225%	302%	126%	117%
		12	46							
37	30	10	32	**1,110**	23,310	8,391,600	268%	360%	151%	140%
		12	39							
40	20	6	27	**800**	16,800	6,048,000	193%	260%	109%	101%
		10	45							
		12	54							
		10	45							
		12	54							
50	20	6	22	**1,000**	21,000	7,560,000	242%	324%	136%	126%
		10	36							
		12	43							
	30	10	24	**1,500**	31,500	11,340,000	362%	487%	203%	189%
		12	29							

Consists (trains) of at least 10 containers are needed to maintain throughput at fixed-guideway system terminals.

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Line Haul Capacity Analysis

Operating Schedule	
hours per day	21
days per year	360

Off-Dock / Near-Dock (CSI)	
Port Build	2,330,000
Port No Build	3,130,000

+ East of Los Angeles / Transload (Tioga)	
Port Build	3,658,000
Port No Build	2,443,000
Port Build	**5,988,000**
Port No Build	**5,573,000**

System Variables - Line Haul			System Capacity (containers)			Capacity/Demand Market Share		Capacity/Demand Market Share	
Number of Guideway Tracks	Headways (Seconds Per Track)	Unit of Dispatch [Vehicles Dispatch]	Hourly Capacity	Daily Capacity	Annual Capacity	% of Port No Build Scenario	% of Port Build Scenario	% of Port No Build Scenario	% of Port Build Scenario
2	120	6	**360**	7,560	2,721,600	87%	117%	49%	45%
2	90	6	**480**	10,080	3,628,800	116%	156%	65%	61%
2	120	10	**600**	12,600	4,536,000	145%	195%	81%	76%
2	60	6	**720**	15,120	5,443,200	174%	234%	98%	91%
2	120	12	**720**	15,120	5,443,200	174%	234%	98%	91%
4	120	6	**720**	15,120	5,443,200	174%	234%	98%	91%
2	**90**	**10**	**800**	**16,800**	**6,048,000**	**193%**	**260%**	**109%**	**101%**
2	90	10	**800**	16,800	6,048,000	193%	260%	109%	101%
2	90	12	**960**	20,160	7,257,600	232%	311%	130%	121%
4	90	6	**960**	20,160	7,257,600	232%	311%	130%	121%
2	60	10	**1,200**	25,200	9,072,000	290%	389%	163%	152%
4	120	10	**1,200**	25,200	9,072,000	290%	389%	163%	152%
4	**90**	**10**	**1,600**	**33,600**	**12,096,000**	**386%**	**519%**	**217%**	**202%**

The limiting factor for "through-put" of the fixed guideway system is loading and unloading capacity – not mainline capacity.

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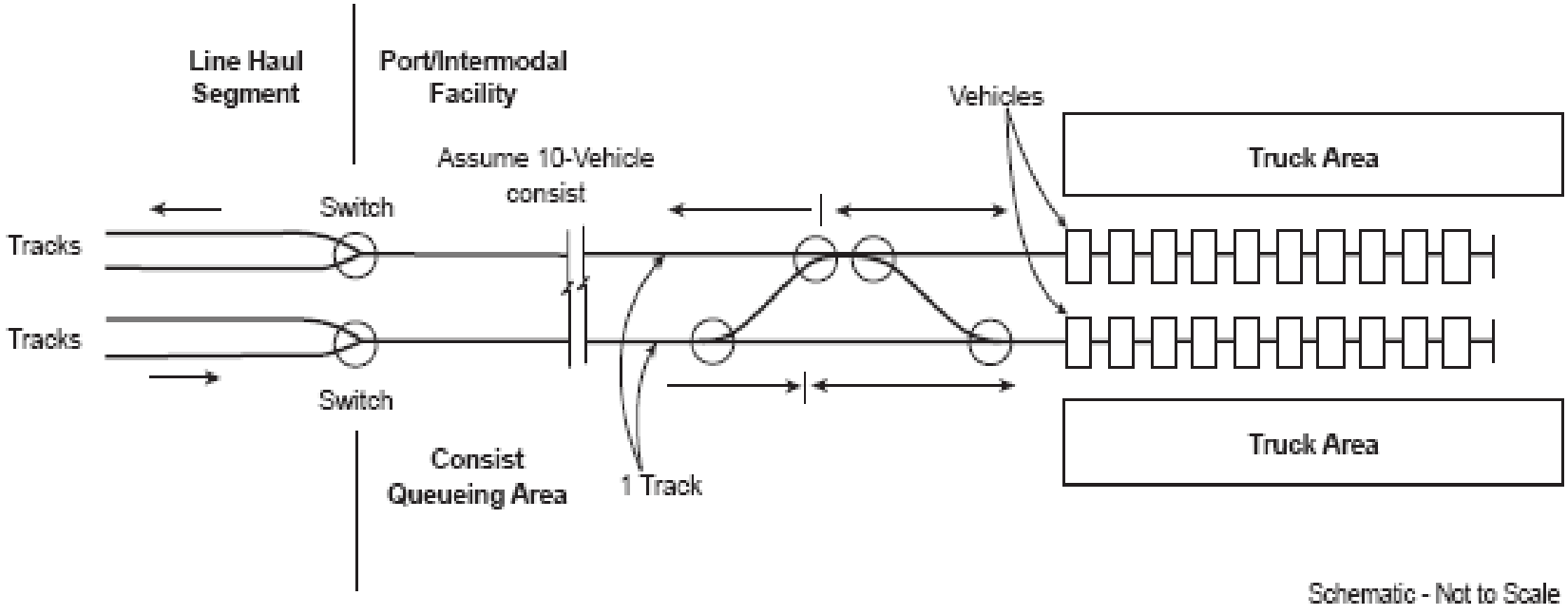
Terminal Interface Requirements

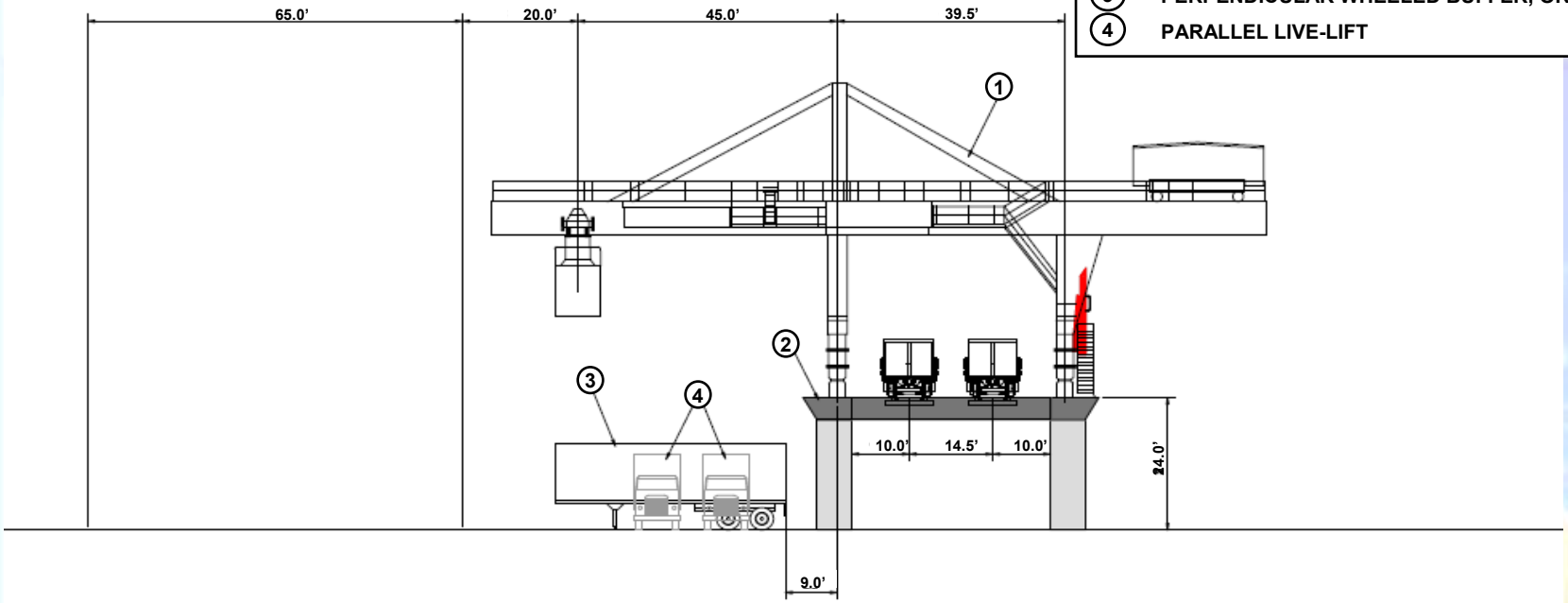
Ports and Intermodal Rail Facilities both require 31-37 station tracks for loading and unloading



Cross Section of a Two-Guideway "Station"

KEY NOTES

1. SEMI-AUTOMATED RAIL-MOUNTED GANTRY CRANE WITH ROTATING HEAD BLOCK AND REMOTE OPERATORS
2. ELEVATED PLATFORM
3. PERPENDICULAR WHEELED BUFFER, OR
4. PARALLEL LIVE-LIFT



ASSUMED CAPACITY = 250,000 LIFTS (450,000 TEUs) PER YEAR

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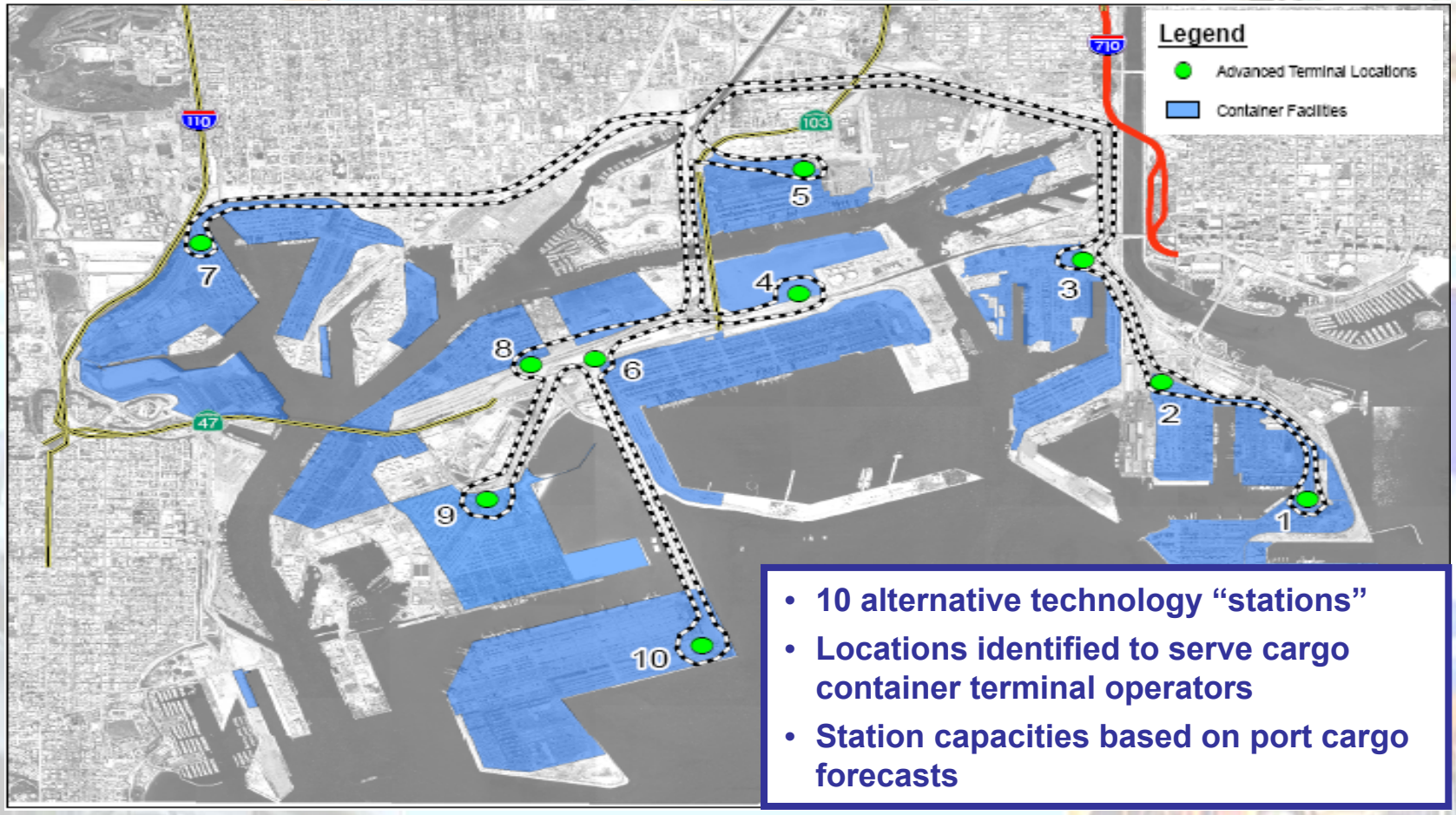
Port Property and Infrastructure Requirements



- 10 alternative technology "stations"
- Locations identified to serve cargo container terminal operators
- Station capacities based on port cargo forecasts

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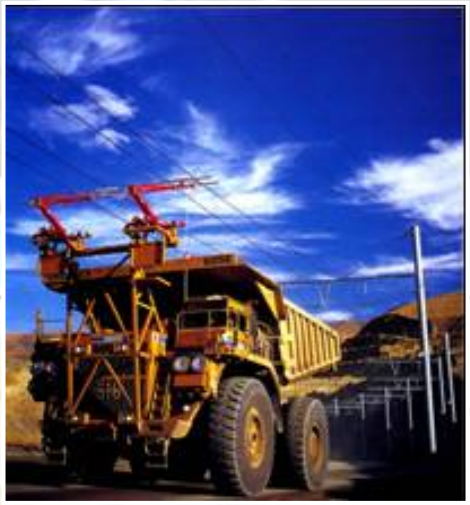
Another Potential Technology Solution?

Electric Trolley Coach

Electric Mine Truck



Battery Drayage Truck

A electric / battery truck solution could provide flexible capacity without extensive terminal property and infrastructure requirements

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Electric / Battery Truck Technology

- Vehicles to combine features of proven technologies in service today
- Within the freight corridor, vehicles powered by electrical overhead catenary, third rail, embedded pavement power source, linear induction, or some combination of these.
- Off the freight corridor, vehicles powered by batteries

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Electric / Battery Truck Capacity Analysis

East of Los Angeles (Tioga)	
Port No Build	2,443,000
Port Build	3,658,000

Off Dock / Near Dock (CSI)	
Port No Build	3,130,000
Port Build	2,330,000

Combined Numbers (CSI + Tioga)	
Port No Build	5,573,000
Port Build	5,988,000

days per year 360

Roadway Capacity	System Variables		System Capacity (containers)			Capacity/Demand Market Share		Capacity/Demand Market Share	
Maximum Capacity of Typical Freight Guideway Per Lane Per Hour	Lanes	Hours of Operation	Hourly	Daily	Annual	% of Port No Build Scenario	% of Port Build Scenario	% of Port No Build Scenario	% of Port Build Scenario
840	2	20	1,680	33,600	12,096,000	386%	519%	217%	202%
840	2	21	1,680	35,280	12,700,800	406%	545%	228%	212%
840	2	22	1,680	36,960	13,305,600	425%	571%	239%	222%
840	2	23	1,680	38,640	13,910,400	444%	597%	250%	232%
840	2	24	1,680	40,320	14,515,200	464%	623%	260%	242%
840	4	20	3,360	67,200	24,192,000	773%	1038%	434%	404%
840	4	21	3,360	70,560	25,401,600	812%	1090%	456%	424%
840	4	22	3,360	73,920	26,611,200	850%	1142%	478%	444%
840	4	23	3,360	77,280	27,820,800	889%	1194%	499%	465%
840	4	24	3,360	80,640	29,030,400	927%	1246%	521%	485%

Zero-emission truck capacity greatly exceeds that of a fixed guideway solution

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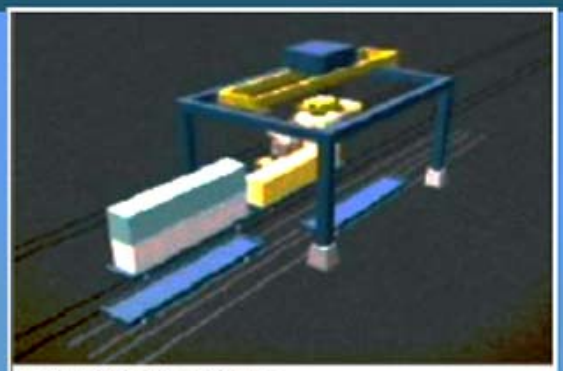
Potential Technologies Now Evaluated

Magnetic Levitation

Exclusive Contact Guideway



Automated Load Unload Station

Electric/Battery Powered Trucks

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Summary: Automated Fixed Guideway Technology

PRO

- Fulfills zero emissions objective
- Numerous commercial proponents
- Could be driverless
- Political support
- Futuristic image
- Potential new domestic industry

CON

- Significantly Higher Costs
- Greater uncertainty
- Serves limited market
- Limited expansion
- Terminal space / infrastructure requirements
- R&D, testing, commercial proof still required

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Summary: Electric / Battery Truck Technology

PRO

- Fulfills zero emissions objective
- Compatible with existing facilities
- Requires significantly less terminal infrastructure
- Greater operational flexibility
- Lower cost
- Higher capacity
- Enables upgrade to more advanced technology
- Integrates proven, available technologies
- Easier to expand beyond I-710 corridor

CON

- Dependent on developing battery / hybrid technologies
- Potential limited range beyond I-710 Freight Corridor
- No industry 'volunteers' (yet)

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Summary: What Have We Learned?

- Zero-emission container transport technologies are feasible
- No such systems have yet been proven in commercial application
- A holistic approach is needed to evaluate any zero-emission technology
- A viable system must serve multiple origins and destinations
- Zero-emission technology will evaluated as part of the I-710 EIR/EIS
- For now, zero-emission trucks will be the subject of environmental evaluation
- The electrical requirements of zero-emission technology must be considered, including availability and cost of power from renewable sources
- GCCOG will remain technology-neutral as this solution evolves, and will continue to support the process

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What's Next

I-710 Freight Corridor will consider two technology alternatives:

1. **Conventional trucks** (new diesel, LNG, CNG, etc.)
2. **Zero-Emission** trucks:
   - Battery powered on terminals
   - Electrically powered in freight corridor

The design of the freight corridor will also assume possible future conversions, or initial construction, as feasible (which may require additional environmental analysis and approval), of a fixed track guideway family of alternative technologies, e.g. Mag-Lev

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What's Next

A range of alternatives for the I-710 EIR/EIS is needed to fulfill CEQA/NEPA requirements.

On the basis the Alternative Technology Study, the following solutions were recommended for phased implementation for the I-710 Freight Corridor:

- Truck Lanes (Freight Corridor)
- Low-Emission (Diesel) Trucks
- Zero-Emission (Electric / Battery) Trucks
- Automated Fixed Guideway (future potential)

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