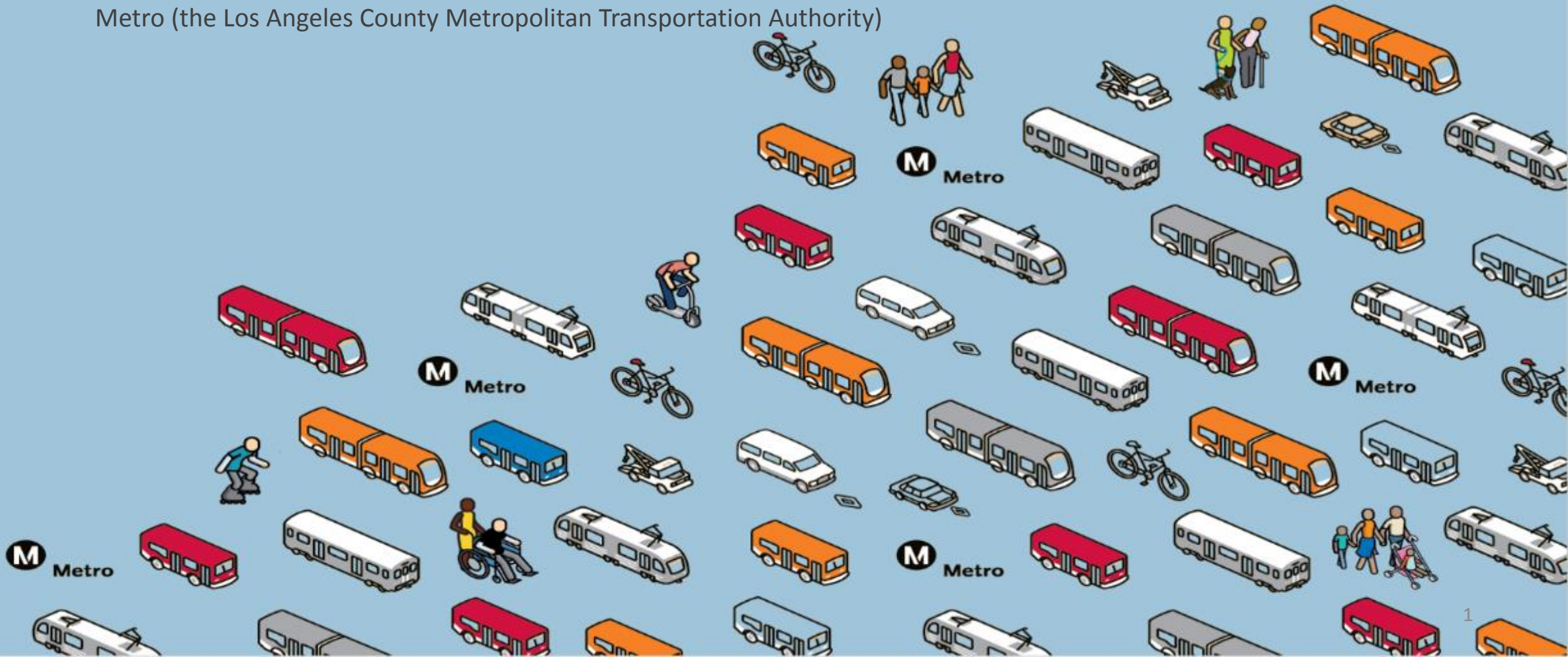


# Metro's Battery Electric Bus Overview

California Transit Association's 53<sup>rd</sup> Annual Fall Conference & Expo

Marc Manning  
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Metro (the Los Angeles County Metropolitan Transportation Authority)



# System Overview

- Bus Service
    - Service Area of 1,433 sq. miles
    - 170 Bus Routes
    - Ridership of ~285 Million in 2017
  - Metro has 14 Divisions with 2367 buses
    - 388 60 ft Buses
    - 1979 Non-Articulated Buses
      - 637 45 ft Buses
      - 1292 40 ft Buses
      - 50 32 ft Buses.
    - 3 Divisions are contracted (176 buses)
    - 3 Sub-fleets
      - Red Buses are Rapid
      - Poppy Buses are Local
      - Silver Buses are Express
- (Silver and Orange Line BRTs)



Rapid Bus



Local Bus



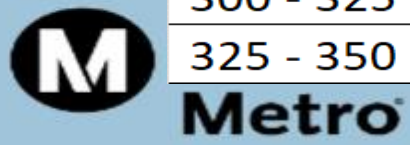
Express Bus



# System Vehicle Block Information

Vehicle Block Range (miles)	# of Blocks	Cumulative %	Battery Capacity (kW-hr)	2017 Battery Cost Per Bus	2030 Battery Cost Per Bus
0 - 25	166	5.4%	103	\$ 21,515	\$ 7,206
25 - 50	754	29.8%	206	\$ 43,029	\$ 14,412
50 - 75	543	47.4%	309	\$ 64,544	\$ 21,618
75 - 100	309	57.4%	412	\$ 86,059	\$ 28,824
100 - 125	342	68.5%	515	\$107,574	\$ 36,029
125 - 150	367	80.4%	618	\$129,088	\$ 43,235
150 - 175	260	88.8%	721	\$150,603	\$ 50,441
175 - 200	161	94.1%	824	\$172,118	\$ 57,647
200 - 225	105	97.5%	926	\$193,632	\$ 64,853
225 - 250	53	99.2%	1029	\$215,147	\$ 72,059
250 - 275	18	99.8%	1132	\$236,662	\$ 79,265
275 - 300	2	99.8%	1235	\$258,176	\$ 86,471
300 - 325	4	100.0%	1338	\$279,691	\$ 93,676
325 - 350	1	100.0%	1441	\$301,206	\$100,882

- Estimated Battery Capacity based on 3.5 kW-hr/mile
  - Highest average energy consumption experienced by LA Metro
  - Assumes All Bus Lengths with same energy consumption.
- 85% of battery capacity is usable.
- This doesn't account for end of life.
- Doesn't consider GVWR impact of Battery Capacity.
- Battery cost per bus based on Bloomberg New Energy Finance (2018). *Electric Buses in Cities*.
  - 2017: \$209/kW-hr
  - 2030: \$70/kW-hr





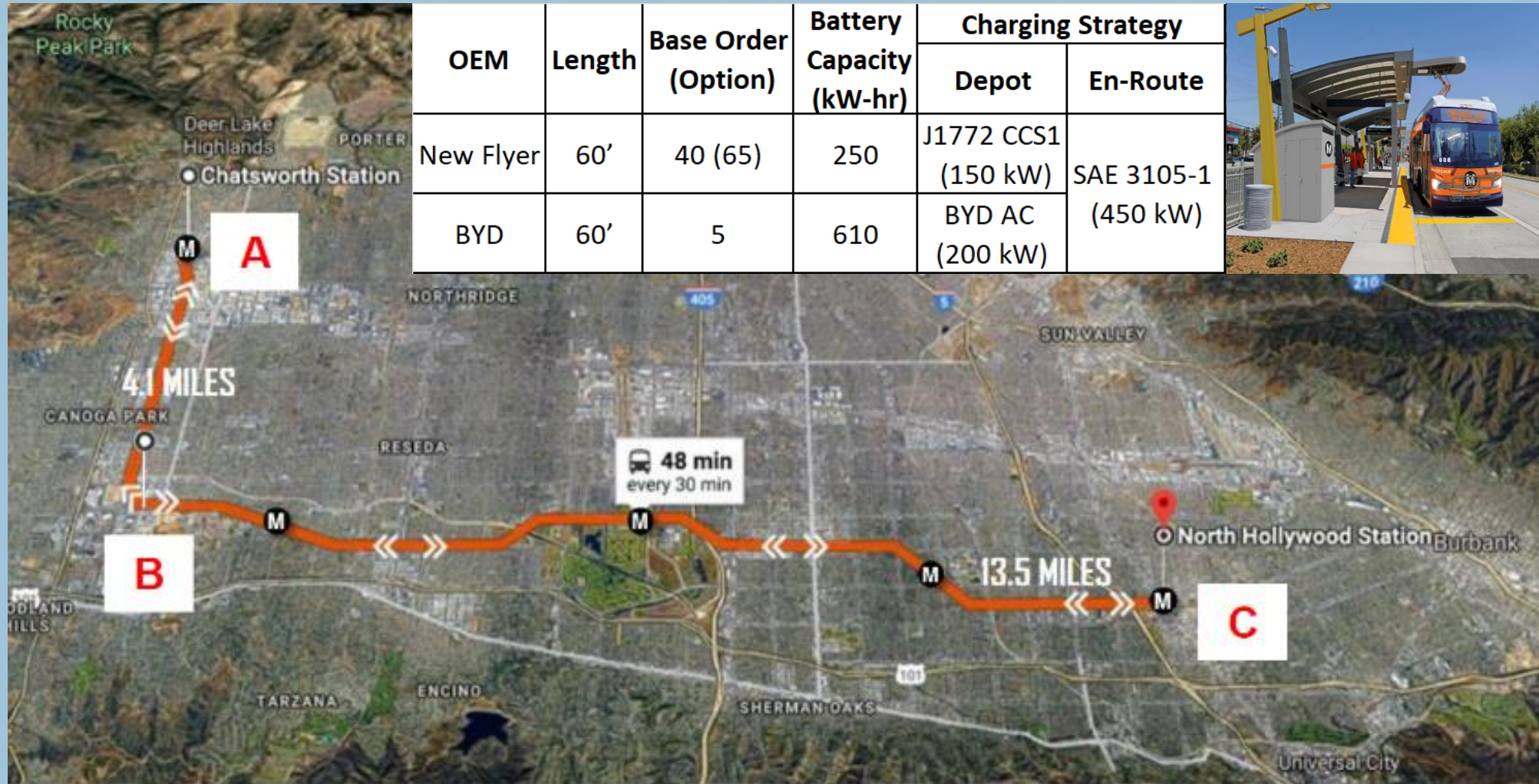
# Battery Electric Bus Vehicle Block Information

Vehicle Block Range (miles)	Silver Line		Orange Line		Other	
	# of Blocks	Cumulative %	# of Blocks	Cumulative %	# of Blocks	Cumulative %
0 - 25	0	0.0%	0	0.0%	166	5.6%
25 - 50	0	0.0%	7	12.5%	747	30.9%
50 - 75	19	25.7%	17	42.9%	507	48.1%
75 - 100	13	43.2%	0	42.9%	296	58.1%
100 - 125	16	64.9%	5	51.8%	321	68.9%
125 - 150	5	71.6%	3	57.1%	359	81.1%
150 - 175	5	78.4%	4	64.3%	251	89.6%
175 - 200	4	83.8%	5	73.2%	152	94.7%
200 - 225	0	83.8%	2	76.8%	103	98.2%
225 - 250	2	86.5%	10	94.6%	41	99.6%
250 - 275	6	94.6%	3	100.0%	9	99.9%
275 - 300	1	95.9%	0	100.0%	1	99.9%
300 - 325	2	98.6%	0	100.0%	2	100.0%
325 - 350	1	100.0%	0	100.0%	0	100.0%

- Electrifying 2 Bus Rapid Transit (BRT) Lines – Orange & Silver Lines
  - En-Route Charging achieves Vehicle Blocks not allowed with existing technology
  - Reduces Capital Cost required for High Voltage Batteries



# Orange Line – Route Overview

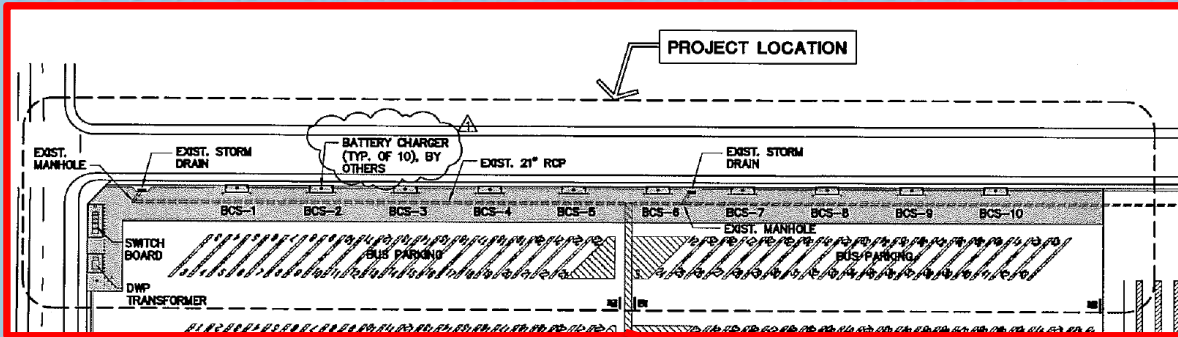


OEM	Length	Base Order (Option)	Battery Capacity (kW-hr)	Charging Strategy	
				Depot	En-Route
New Flyer	60'	40 (65)	250	J1772 CCS1 (150 kW)	SAE 3105-1 (450 kW)
BYD	60'	5	610	BYD AC (200 kW)	





# Orange Line - Division 8 Depot Charging



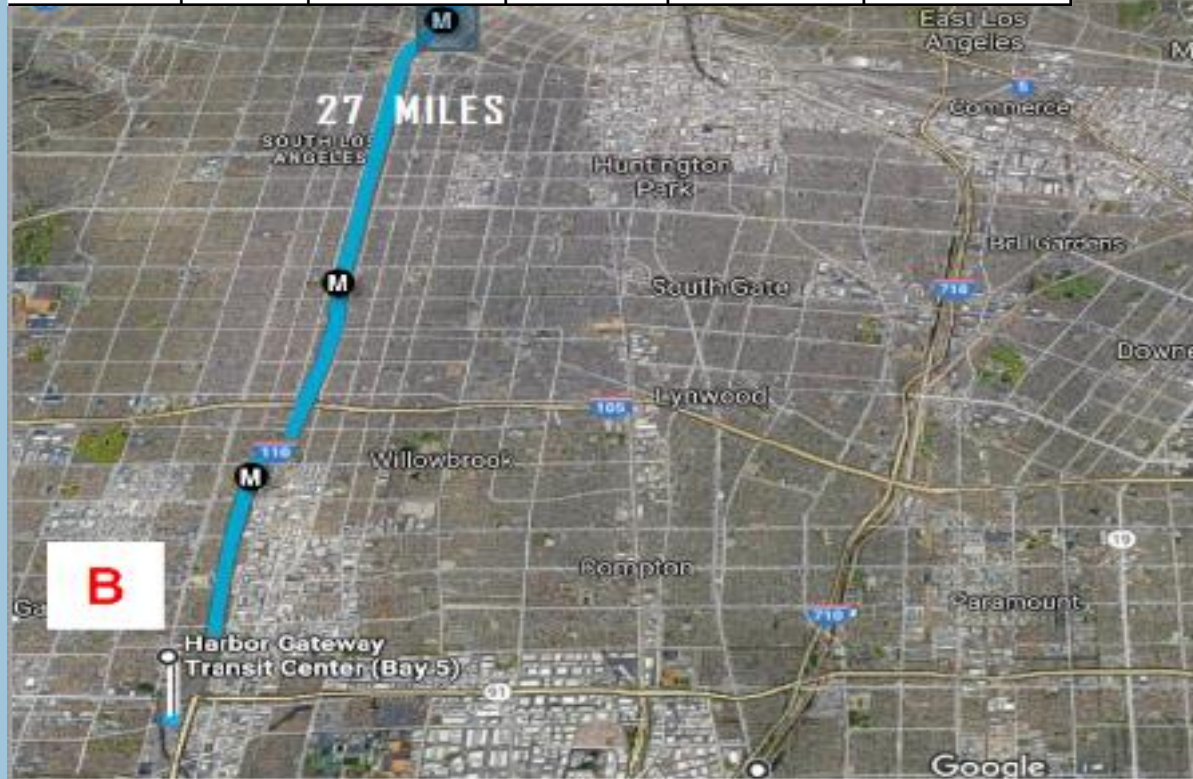
Metro





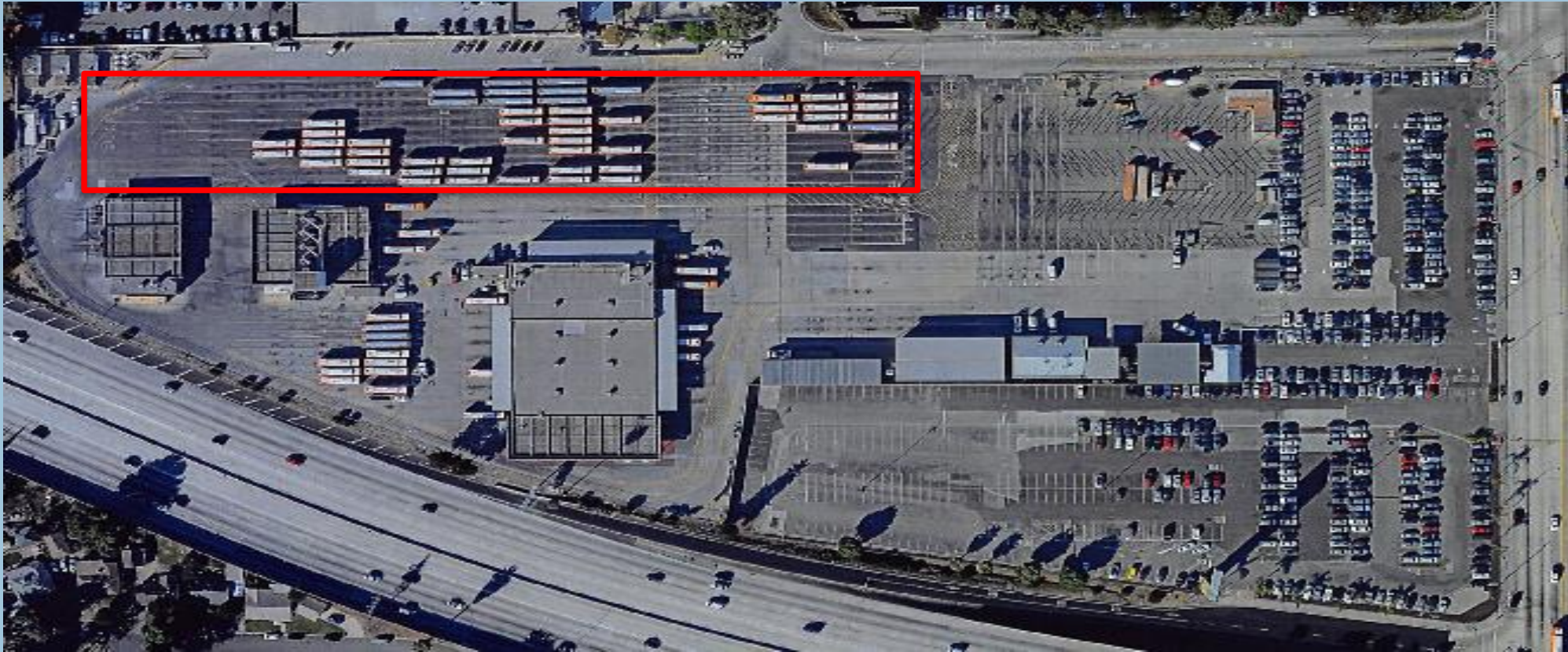
# Silver Line – Route Overview

OEM	Length	Base Order (Option)	Battery Capacity (kW-hr)	Charging Strategy	
				Depot	En-Route
BYD	40'	60 (40)	348	BYD AC (80 kW)	SAE 3105-1 (300 kW)





# Silver Line – Division 9 Depot Charging





# Zero Emission Bus Master Plan

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- Utilize Consultant Services to develop strategies to meet goal of 100% ZE Bus operations by 2030. The Scope of Services includes:
  - Industry Outreach
  - Inventory of Metro's Operations
  - Assessment of Best Industry Practices
  - Evaluation of Compliance with Existing Standards and Codes
  - Support Negotiations of Rate Structures with Utilities
  - Analysis/System Modeling and Phase Options
  - Submittal of Master Plan
  - Develop Action Ready RFP's



# Thank you

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