Reducing Impacts of Goods Movement in the Inland Empire

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CLIMATE SMART TRANSPORTATION AND COMMUNITIES CONSORTIUM

(a Strategic Growth Council Project)

Inland Empire Regional Initiative

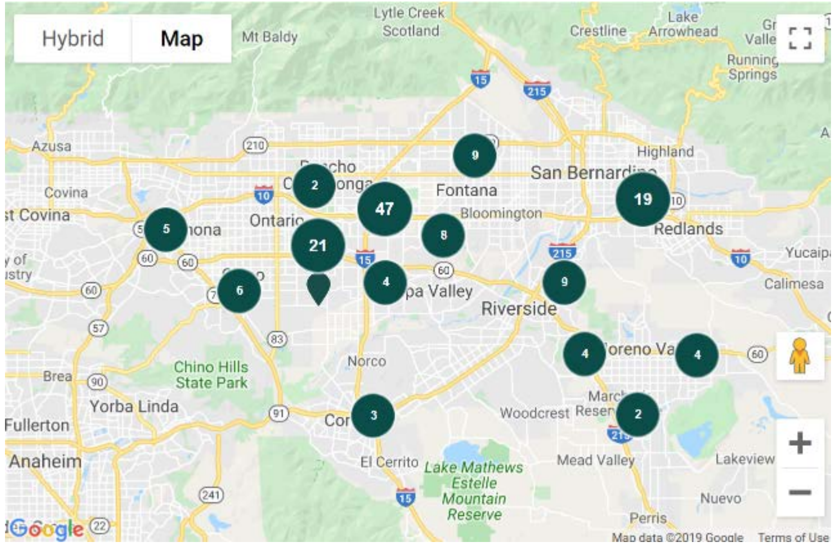
- **UC Davis (ITS)**
- **UC Berkeley (LBNL)**
- **UCLA (Luskin Center)**
- **UCR (CE-CERT & CSI)**
- **UC Irvine (ITS)**

Reducing Impacts of Goods Movement in the Inland Empire

Context

There is explosive growth of warehousing in the Inland Empire, with little attention on transportation needs

- how do these warehouses and associated truck traffic affect residential neighborhoods?
  - – Roadway safety
  - – Traffic congestion
  - ➢ Air quality and pollutant exposure to residents



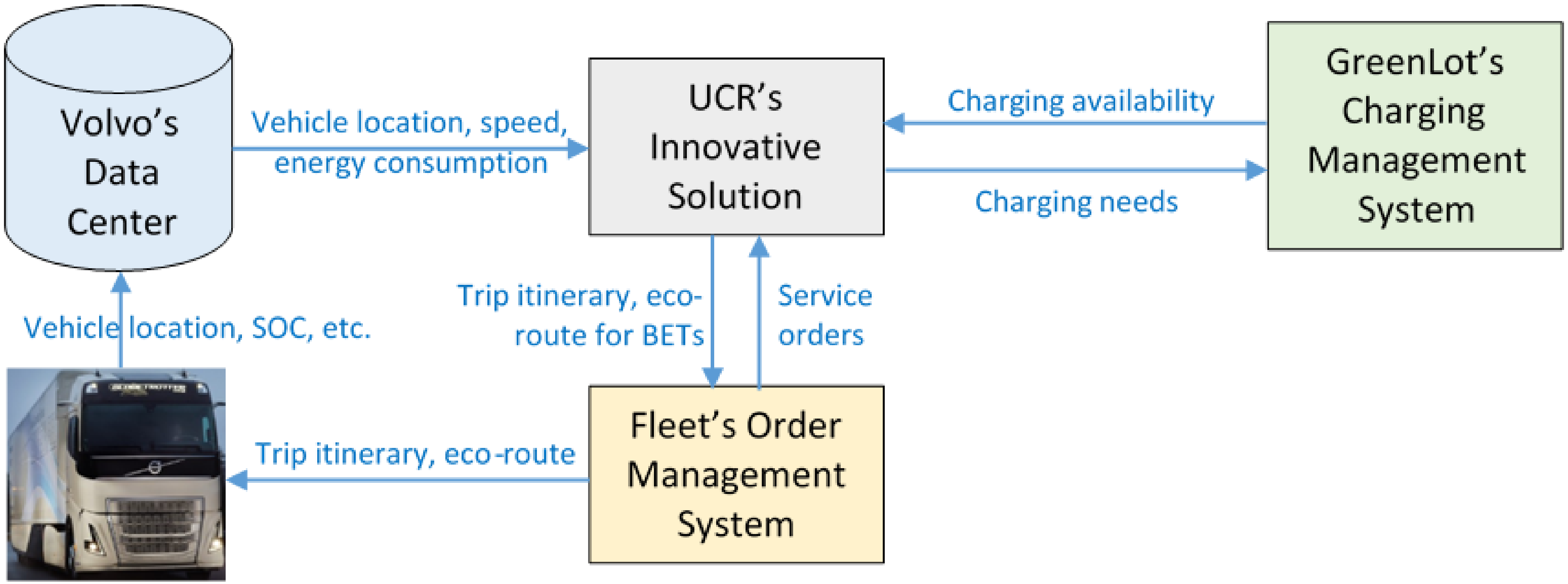
Reducing Impacts of Goods Movement in the Inland Empire

Our Research Tools:

- Heavy Duty Electrification
  - Electric Trucks (currently being tested in pilots)
  - Vehicle charging infrastructure
- Connectivity and (partial) Automation
  - Increased efficiency and safety
  - Driving Assistance, not Driver Displacement
- Advanced Fleet Management tools, including low exposure truck routing, dynamic time-of-day scheduling, geofencing

From VolvoLights Project: https://www.lightsproject.com/

Novel Electric Truck Dispatching Algorithms

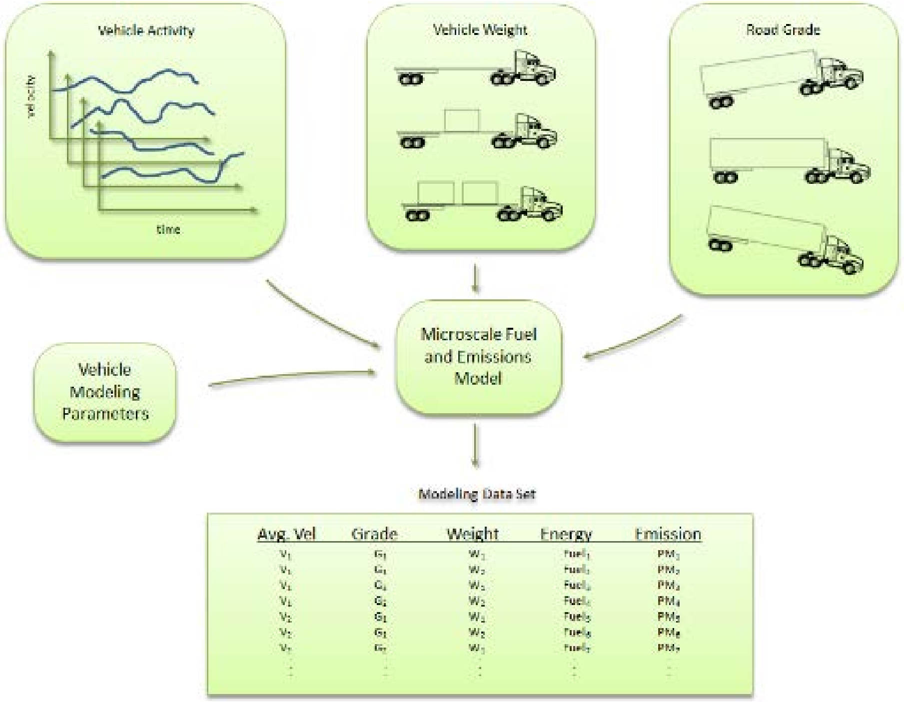


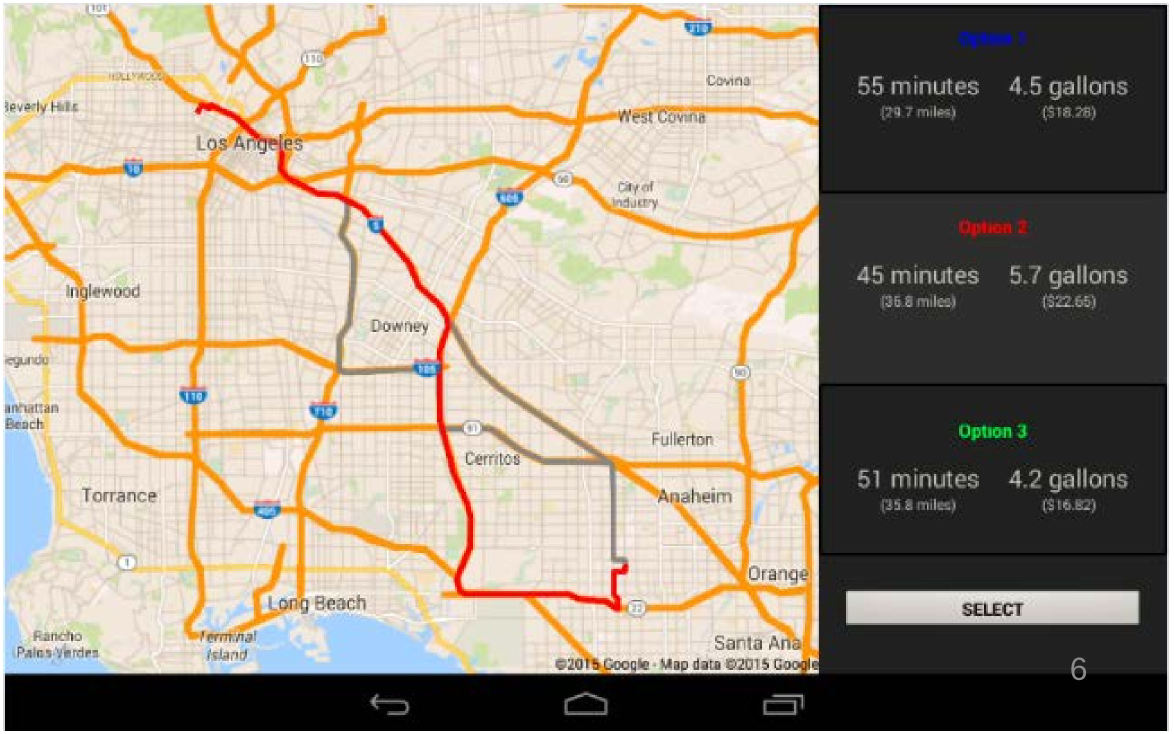
- Optimize dispatching of electric trucks considering their driving range, estimated energy consumption, state of charge (SOC), charging needs, etc.
- Route electric trucks onto "eco-routes" with estimated time of arrival (ETA) within the arrival time window, if available.

https://www.cert.ucr.edu/news/2020/02/19/ucr-ce-cert-joins-volvo-and-other-partners-comprehensive-evaluation-its-class-8

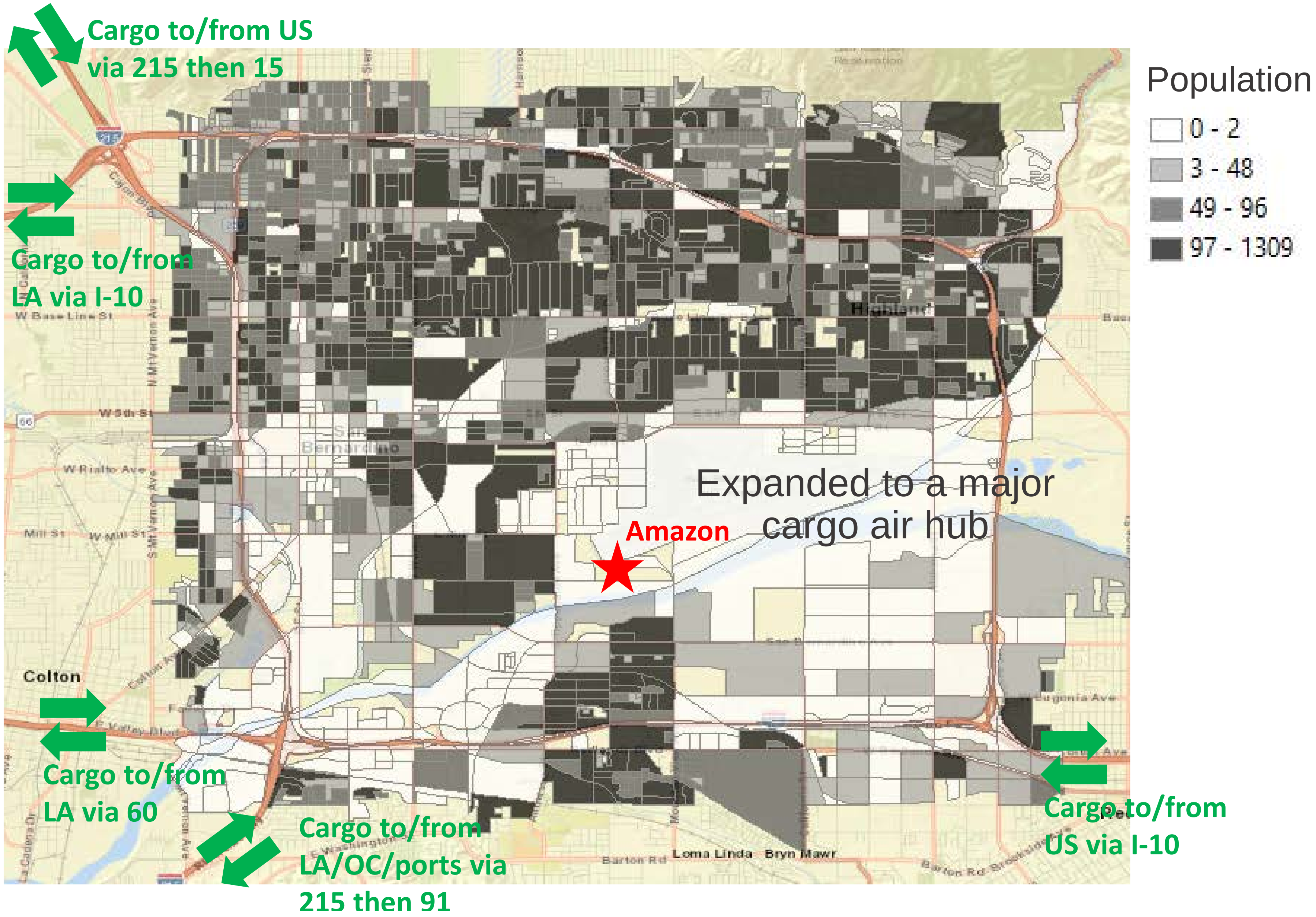
Vehicle Routing:
fastest route, eco-route, low-exposure route

- Most trucks use navigation based on achieving the fastest route
- “Eco-routes” can be chosen that reduce fuel consumption, with a small travel time penalty
- Low-exposure routes can be chosen that reduce exposure of pollutants to local residents ← this is what we are doing as part of this grant

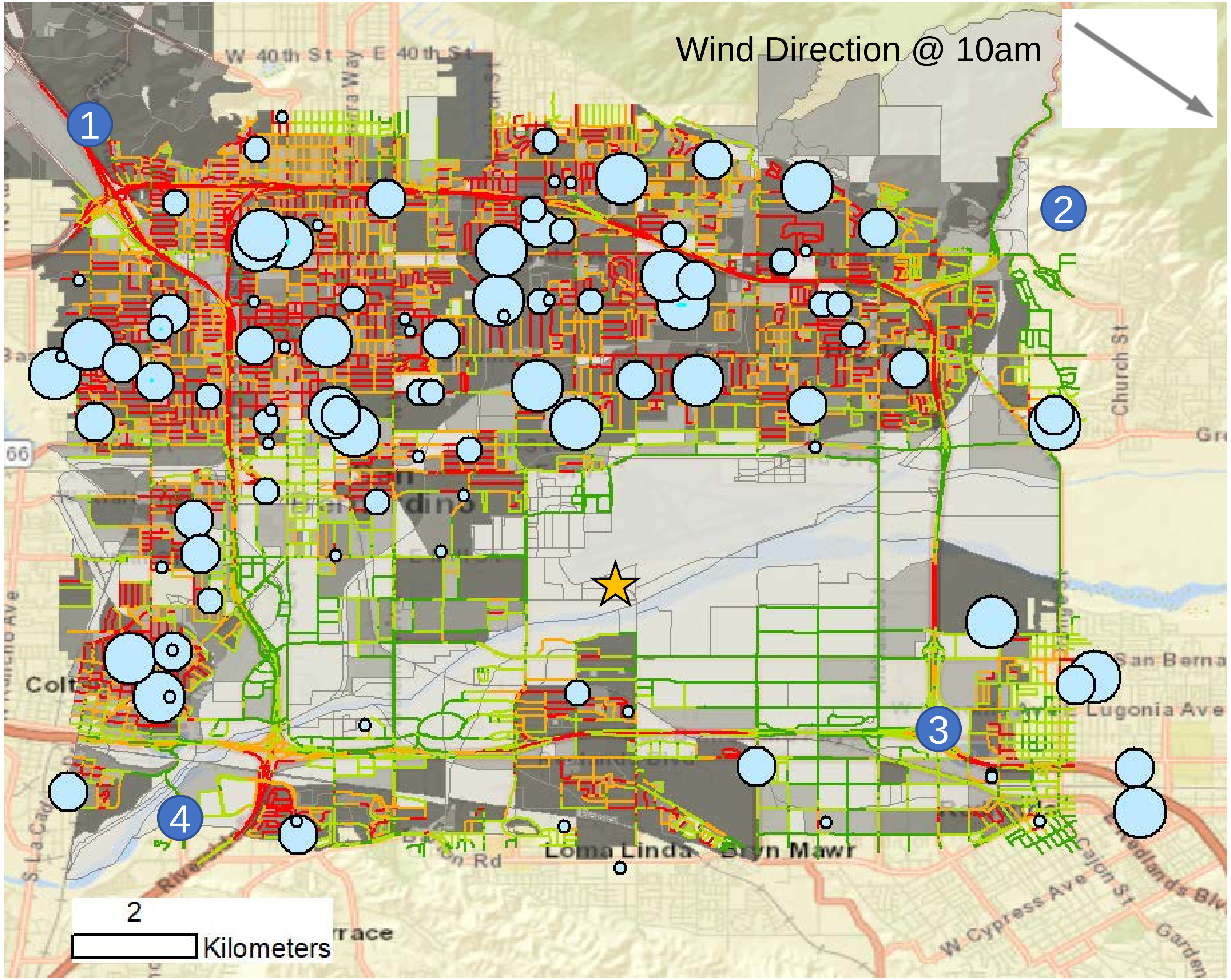




Case Study: San Bernardino Airport Area



San Bernardino Airport at 10am of a typical weekday



Facility Population

- 70 - 283
- 284 - 512
- 513 - 664
- 665 - 2732

Sensitive receptors (schools, assit. living, etc.)

Census Block 2018 Population

Working Hour

- 1
- 2 - 28
- 29 - 57
- 58 - 3505

General population density

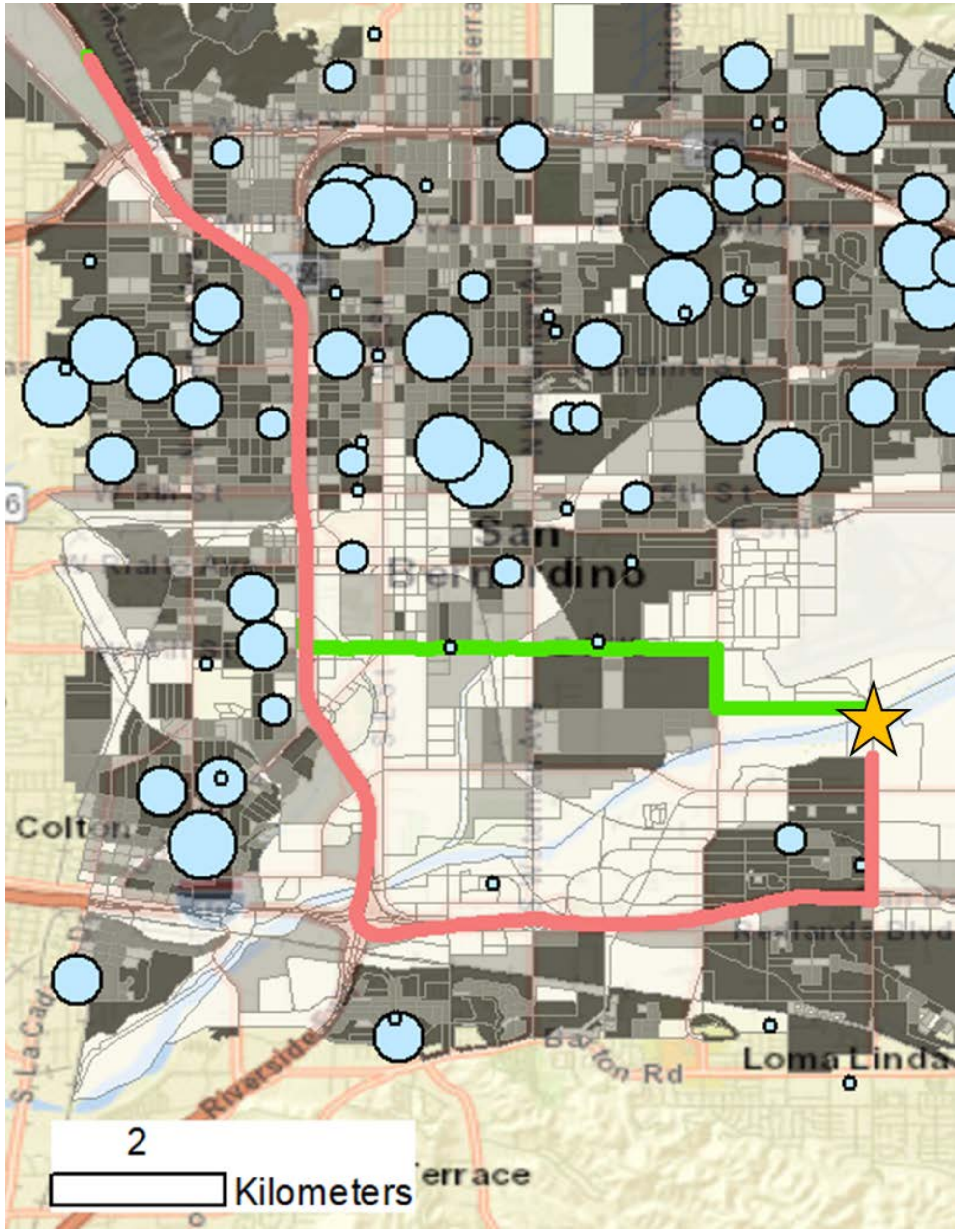
Road Network PM2.5

IM of total population (µg/kg mass)

- 0.000
- 0.001 - 0.003
- 0.004 - 0.009
- 0.010 - 5.277

Roadway exposure rating

San Bernardino Airport at 10am of a typical weekday



Example Route Analysis

- Starting Point: Freeway I -215 South & 210
- Ending Point (warehouse(s)) = Star
- Baseline Route = A → Coral Route
- Alternative Route = B → Green Route

	Driving distance (mile)	Driving duration (min)	$PM_{2.5}$ *IM* (µg)	CO_2 (kg)
Coral, fastest route	11.45	12.99	101.77	18.65
Green, LER	8.16	13.32	97.45	13.73

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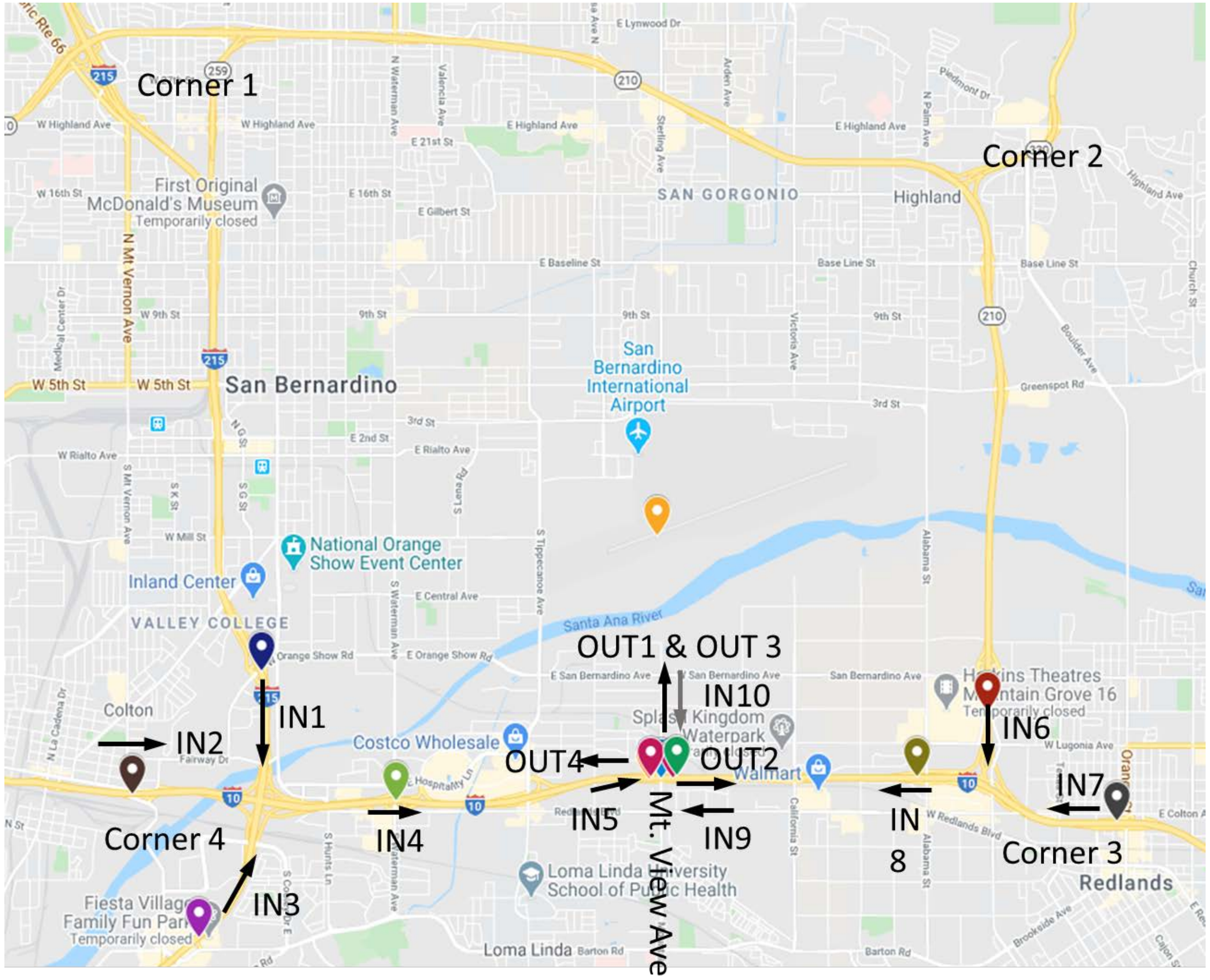
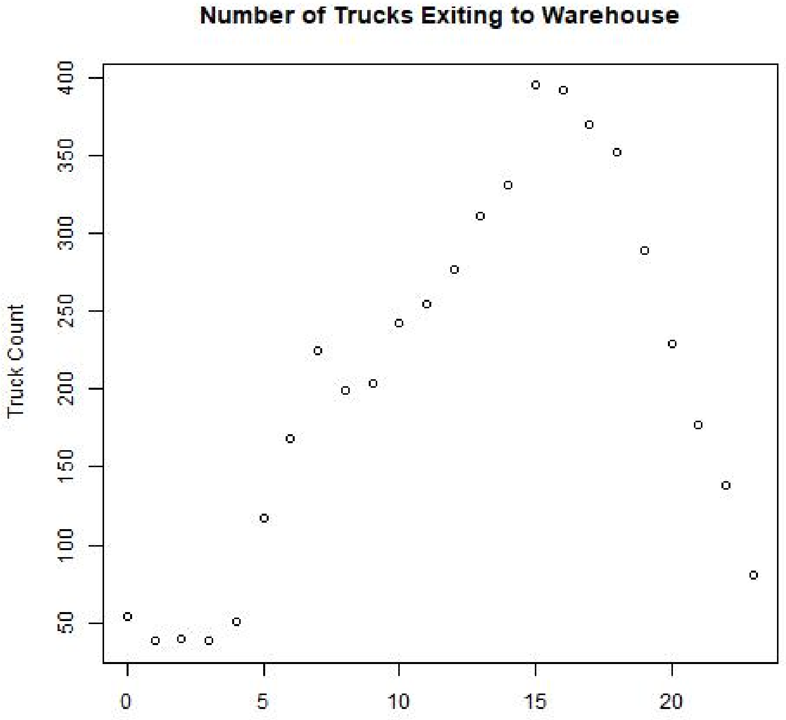


Truck Volume Analysis

- Caltrans PeMS Truck Flow at mainline loop detector stations (LDS)
- Truck volume loading into the hub from four corners of the area is estimated

truck traffic pattern



PeMS Truck volume estimation reference: Kwon et al.

San Bernardino Airport at 10am of a typical weekday

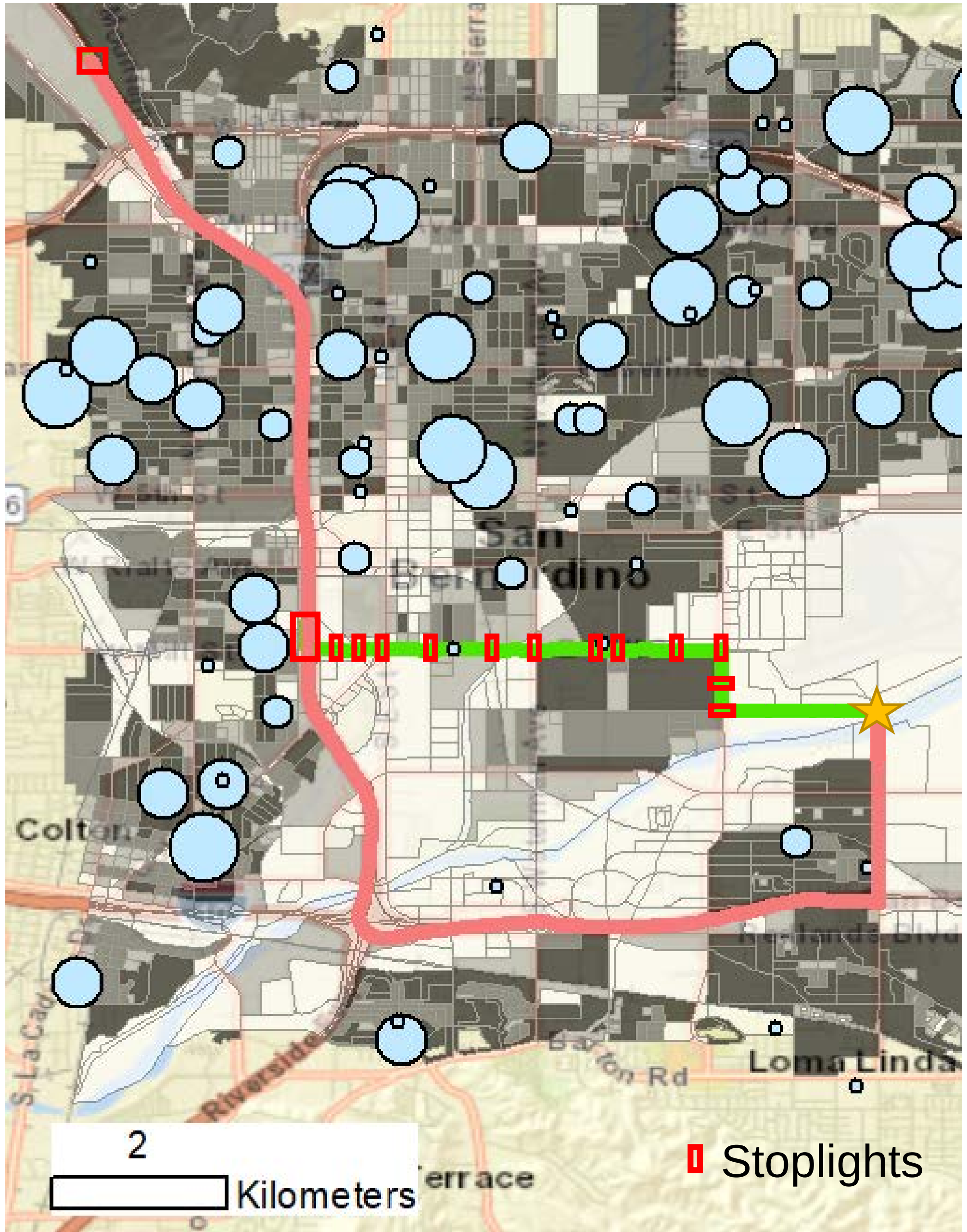
Summary of Low-Exposure Routing (in progress)

June 2020 Truck Flow at 10AM

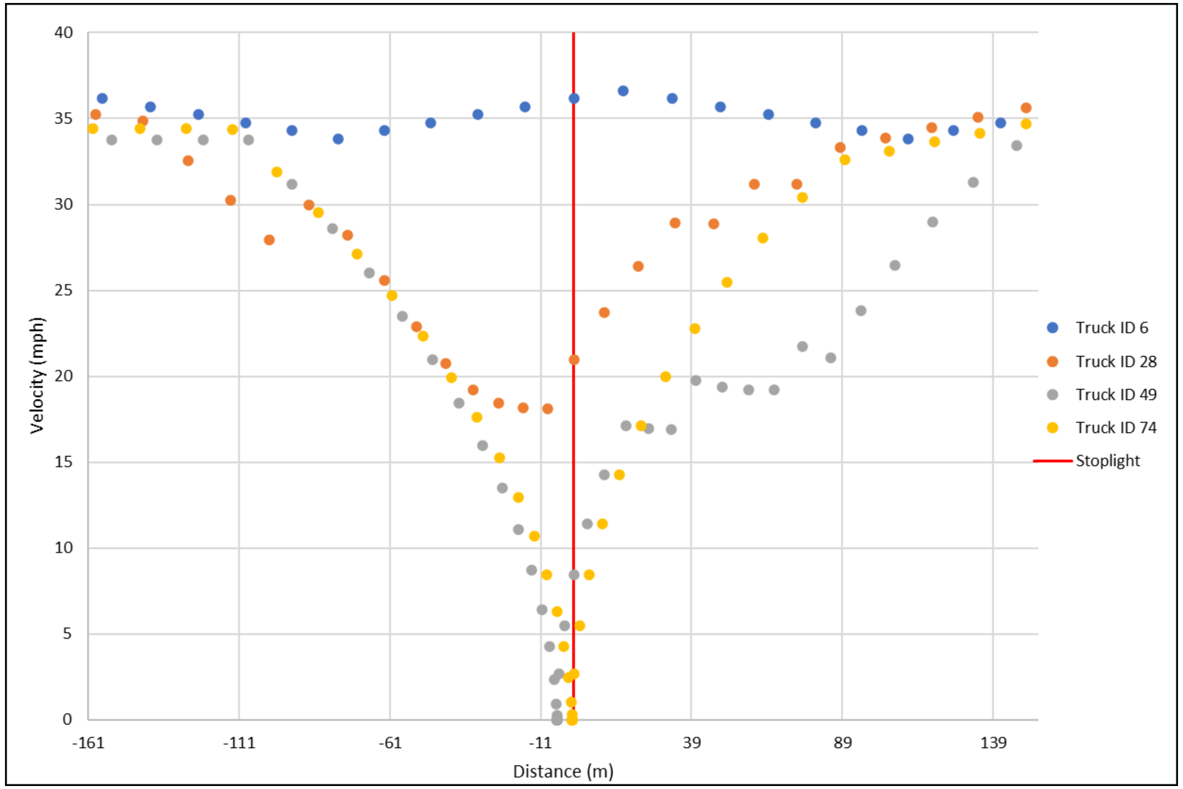
MY 2012 10am		Fastest Route (A)					Low Exposure Route (B)					Difference (v.s. Fastest route)				
Corner #	No. of Trucks	Driving Distance (miles)	Driving duration (min)	$PM_{2.5}$ IM (ug)	NO_x IM (mg)	CO_2 (kg)	Driving Distance (miles)	Driving duration (min)	$PM_{2.5}$ IM (ug)	NO_x IM (mg)	CO_2 (kg)	Driving Distance (miles)	Driving duration (min)	$PM_{2.5}$ IM (ug)	NO_x IM (mg)	CO_2 (kg)
1	56	641	728	203	19	1044	457	634	189	24	769	-184	-94	-14	6	-275
2	11	103	143	13	1	157	88	146	8	1	141	-15	3	-6	-1	-16
3	133	630	967	180	18	1108	659	1268	83	9	1144	29	302	-96	-10	36
4	186	1064	1512	111	12	1851	1074	1731	83	22	1898	10	220	-27	10	46
Total	386	2438	3349	507	51	4161	2278	3780	364	56	3951	-160	431	-143	5	-209
												-7%	13%	-28%	10%	-5%

General Conclusion: **we can achieve a 28% reduction in pollutant exposure and reduce fuel consumption by 5%, but will increase travel time by 13%**

Refined Analysis with Traffic Signals

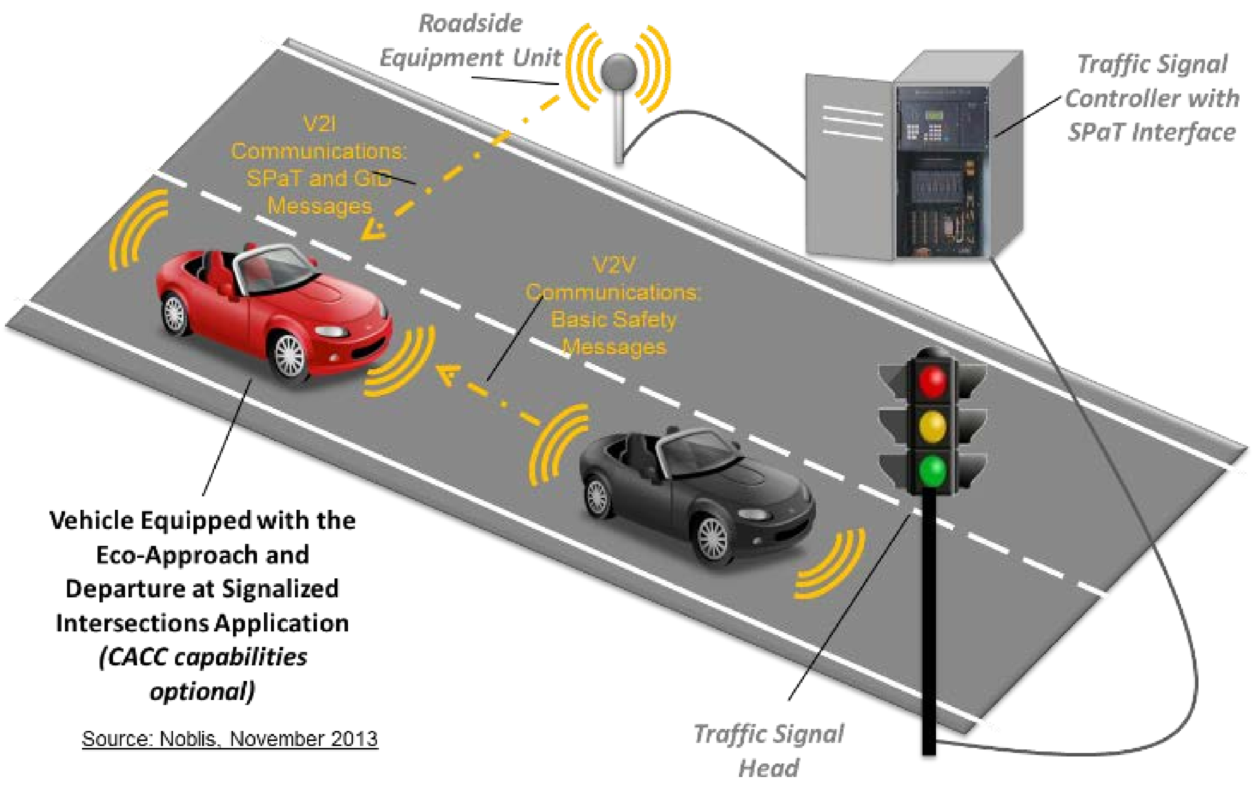


- Previous analysis assumed roughly constant speeds, with no stopping
- This analysis examines the effect of stopping at stop lights (~40 second lost per stop), and the pollutants they emit

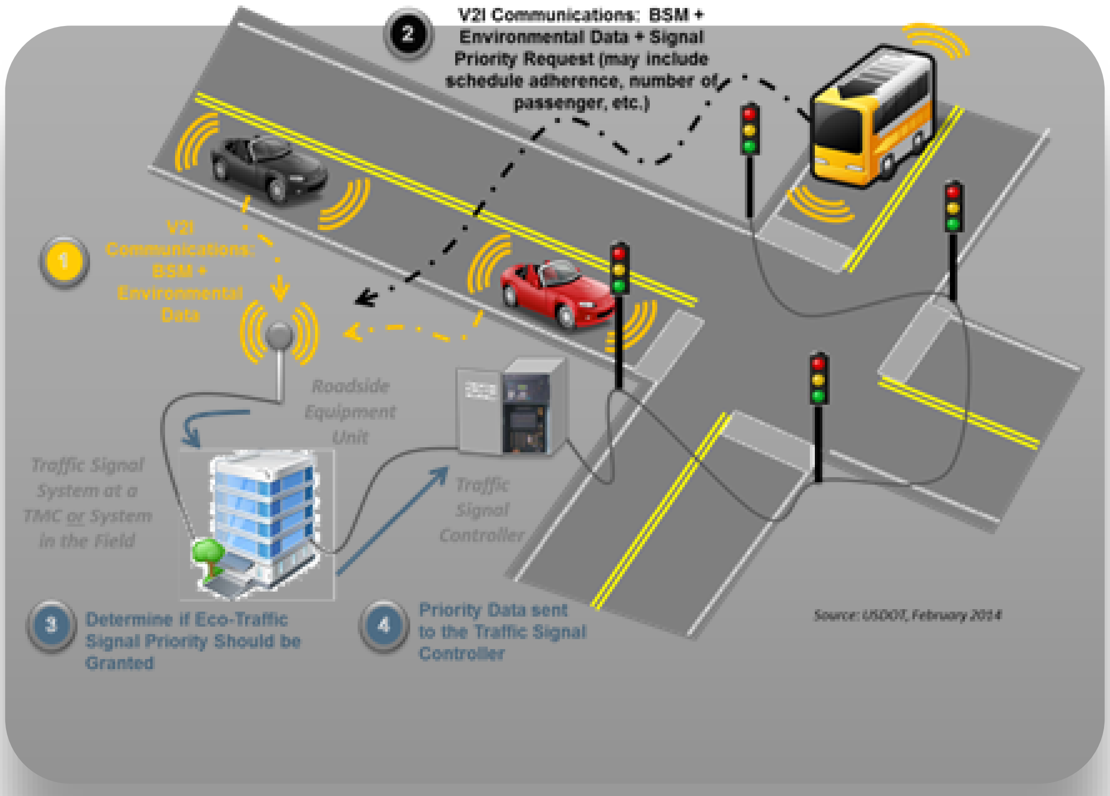


- Stop lights make previous low-exposure routes less effective
- Traffic signals synchronized with vehicle traffic can improve the performance

Other Related Technology that can be Utilized



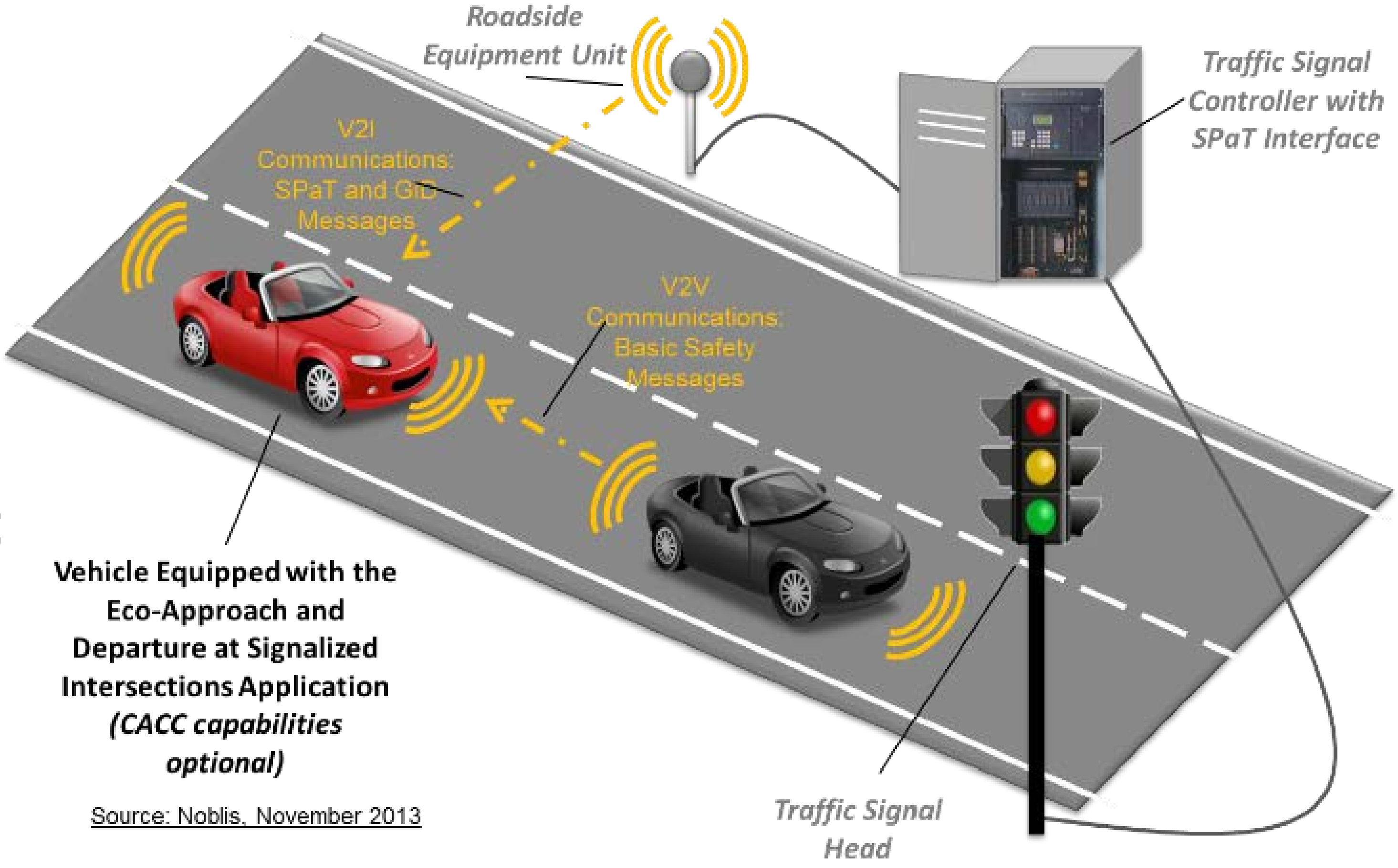
Eco-Approach and Departure



Freight Signal Priority

Eco-Approach and Departure Speed Advice to Drivers

- Application utilizes traffic signal phase and timing (SPaT) data to provide driver recommendations that encourage “green” approaches to signalized intersections
- Example scenarios:
  - Coast down earlier to a red light;
  - Modestly speed up to make it (safely) through the intersection on green
- Energy Savings: 10% - 20%
- Smoother Traffic Flow



Source: Noblis, November 2013

Eco-Approach and Departure Truck Demonstration Event

- March 6, 2019 in Carson, CA
- 1st Eco-Drive demo in L.A. region with demo rides given to over 50 invited attendees
- Partnership between 10 public agencies, 6 technology providers, 1 trucking companies, Volvo, and UCR

Implementation Scenarios - Policy and Regulatory Levels

Possible Adoption of Formal Policies:

- Local and regional transportation and land use departments use their authority to limit the use of certain routes by heavy-duty trucks or designate low-exposure truck routes
  - City of San Bernardino
  - San Bernardino County Transportation Authority
  - California Department of Transportation (Caltrans) District 8

- Air quality regulators adopt indirect source rules that mandate or incentivize alternative routing or geofencing technologies
  - South Coast Air Quality Management District
  - Example: SCAQMD’s Proposed Rule 2305 - Warehouse Indirect Source Rule

Implementation Scenarios - Policy and Regulatory Levels

Possible Voluntary Actions by Firms:

- New industry-level norms: firms adopt low-impact emissions routing guidelines
  - The logistics sector uses emerging routing technologies to divert heavy-duty truck traffic to low-impact routes, accepting a tradeoff between slightly increased delivery time/distance for reducing inhalant exposure of PM 2.5 and NOx to communities and sensitive receptors
  - Bonus: slight reduction in fleet average fuel consumption

- Industry- or firm-specific leaders adopt new standards in the Inland Empire
  - Amazon, the region's largest private-sector employer, pilots innovative alternative routing and geofencing technologies for their delivery fleets in the IE

Thank You!