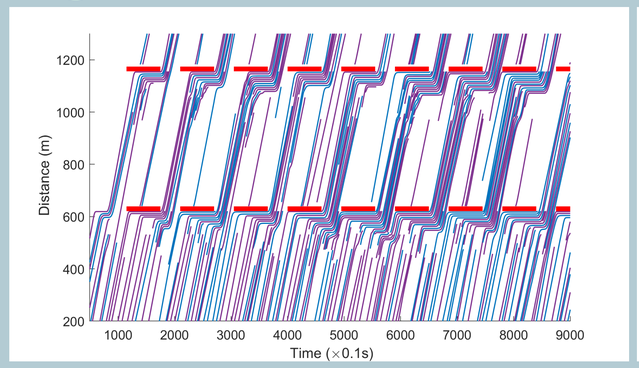
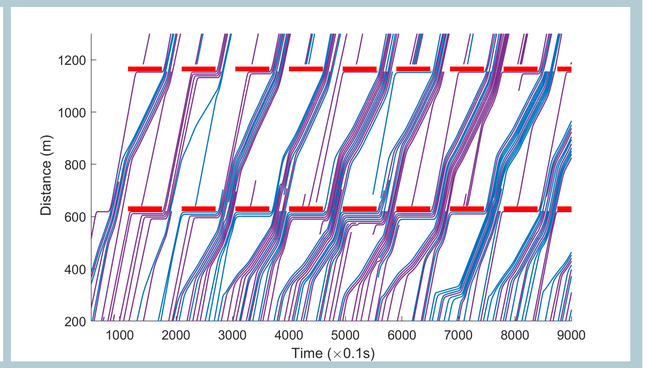
Integrating Vehicle Trajectory Planning and Arterial Traffic Management to Facilitate Eco-Approach and Departure (EAD) Deployment

Hao Liu, Alex A. Kurzhanskiy, Wanshi Hong, Xiao-Yun Lu

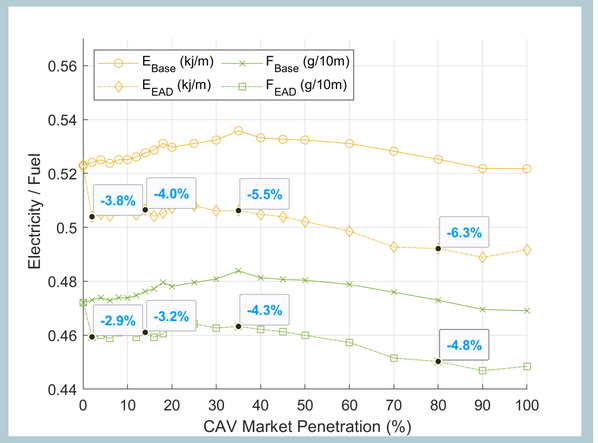
Berkeley UNIVERSITY OF CALIFORNIA · CALIFORNIA PATH · BERKELEY LAB

EAD provides **traffic-level energy savings** by enabling **continuous vehicle motion** in signalized corridors.





EAD is a promising use case for **early-stage** Cooperative Driving Automation (CDA) applications.



Tailored **traffic management** is essential for EAD field deployment.

40% EAD	TT	TT MA	TT ML	TT MI	F	F MA	F ML	F MI
Baseline	146.4	155.7	145.4	138.6	47.6	50.1	50.5	44.5
EAD	166.1	162.0	239.7	175.7	49.6	49.8	64.8	50.0
	13.4%	4.1%	64.9%	26.8%	4.4%	-0.5%	28.4%	12.2%
EAD+TM	154.7	161.1	180.4	144.8	46.2	46.8	54.8	45.1
	2.5%	2.2%	4.7%	5.0%	-4.0%	-7.2%	0.7%	1.7%

TM: traffic management; TT: travel time (s/km); F: fuel consumption rate (g/km)

MA: major through; ML: major left; MI: minor road

Challenges for EAD Field Implementation

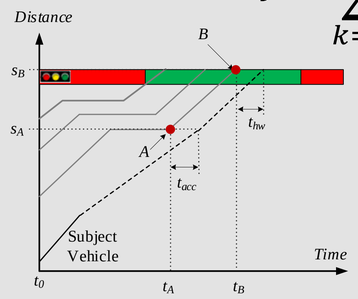
Real-world implementation challenges are not completely addressed in existing studies:

- Limited traffic monitoring
- Disturbances of lane changes
- Competing traffic streams in the same road link
- Computation and communication load

EAD Controller and Traffic Management

A centralized optimal controller realized in an MPC framework

$$Min\ J = \sum_{k=k_0}^{k_f} \left[\omega_u \cdot u^2(k) + \omega_v \cdot (v(k) - V)^2\right] \cdot \Delta t$$



- Input data available at modern intersections
- Generic vehicle models suitable for different types of vehicles
- Position constraints considering queue dynamics
- Centralized control for reducing computation and communication overhead

Traffic management strategies that handle lane changes and competing traffic streams:

- Lane-changing strategy
- Left-turn signal treatment

Acknowledgments: Research funded by the U.S. Department of Energy, Vehicle Technologies Office (VTO) under Energy Efficient Mobility Systems (EEMS) Program on Advancing Driving Automation through Connectivity - project on CDA Applications