

Design Problem (DP)

A DP is abstracted as a monotone map between

provided functionalities and the antichain of required

resources

Design Problem

Towards a Co-Design Framework for Future Mobility Systems

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Functionality/Resources relation:

• v_a as monotone function of costs.

Functionality/Resources relation:

Functionality/Resources relation:

+ - \times - \times + +

More trains require more operators.

I-AMoD

 $n_{
m v,max}$ $t_{
m avg}$

 t_{avg} s.t. I-AMoD system equations.

More trains, higher fixed costs.

Higher speed, more advanced technology.

Subway

Motivation Lack of specifications on its intended service AMoD is a promising market • \$55 billion in 2019, \$557 billion in 2026. How performant should AVs be? • 48 AV companies in California, 80+ in the USA. • What is the best fleet size? Potential benefits: How will AVs affect public transport? • Will the outcome be sustainable. -44% parking spaces -66% emissions economically? environmentally? -90% fatalities -30% travel time The design of AVs and the design of AVs-enabled mobility systems are closely coupled. Scope We develop a co-design framework to solve the problem of designing and deploying an intermodal Autonomous Mobility-on-Demand system, optimizing for its environmental footprint. its performance, the costs it produces, Autonomous Vehicles Design: The vehicle autonomy. The AVs fleet size. Public Transit Design: The public transit service frequency. Problem Setting **Assumptions:** Network flow approach. Time-invariant model. System equations: Flows and AVs conservation. Road congestion. $\mathcal{G}_\mathsf{P} = (\mathcal{V}_\mathsf{P}, \mathcal{A}_\mathsf{P})$ AVs fleet size. Co-Design

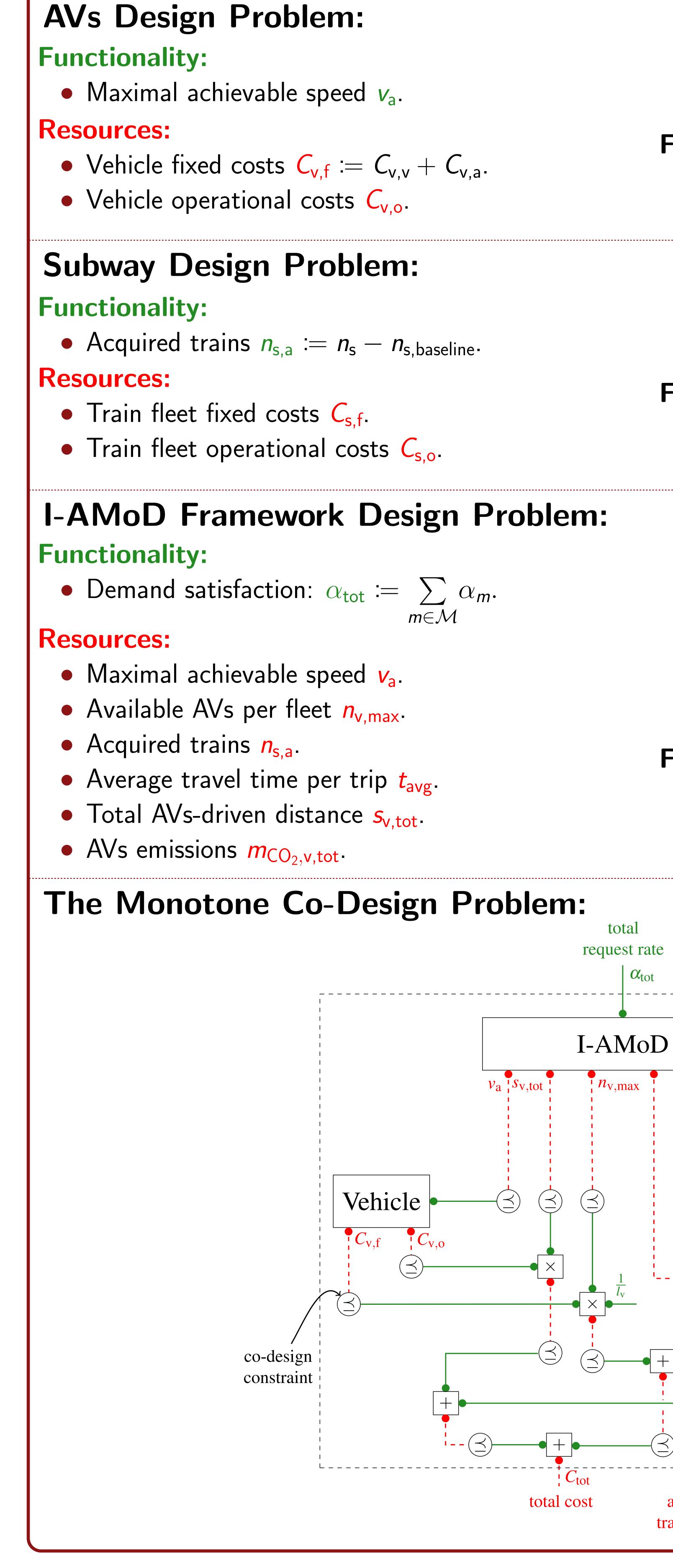
Co-Design Goal: Find the antichain of all rational resources which provide a given functionality.

Co-Design Problem (CDP)

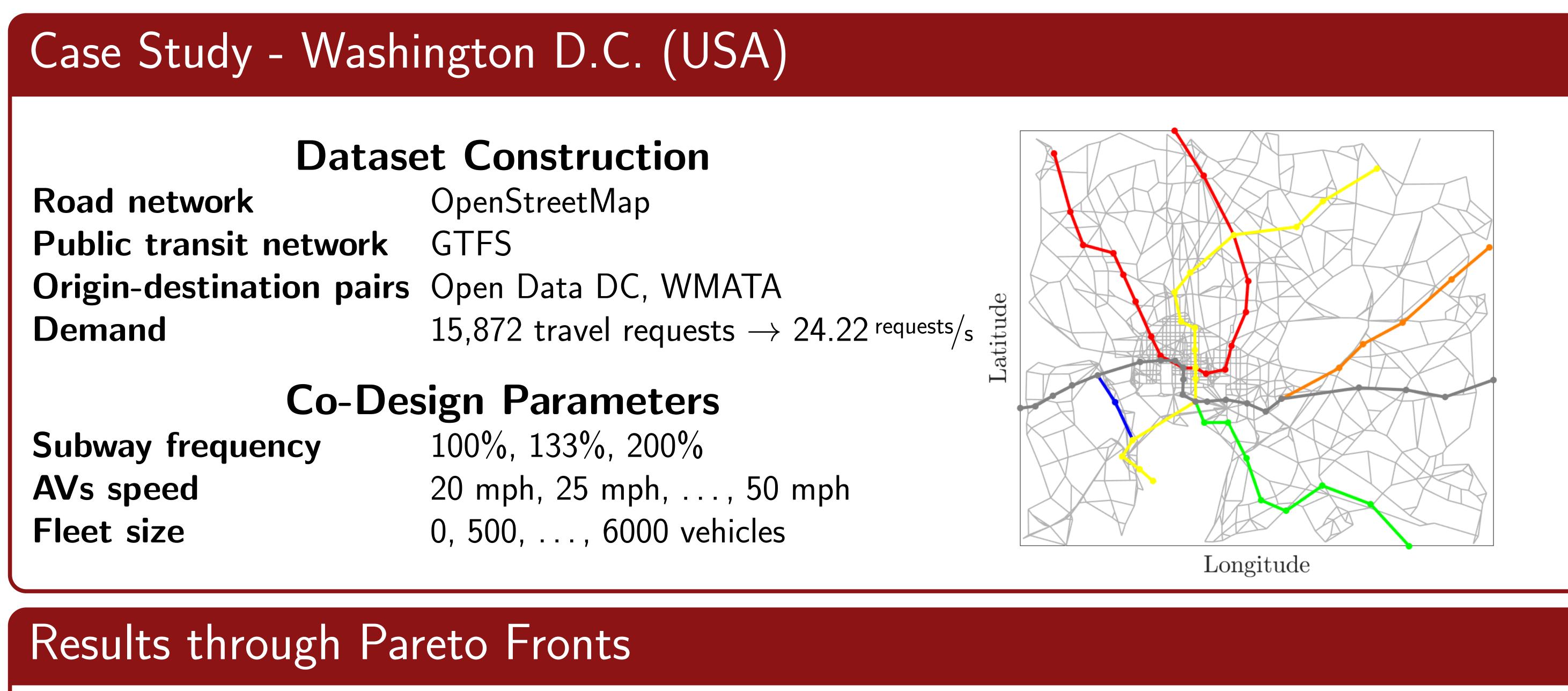
A CDP is an interconnection of individual DPs.

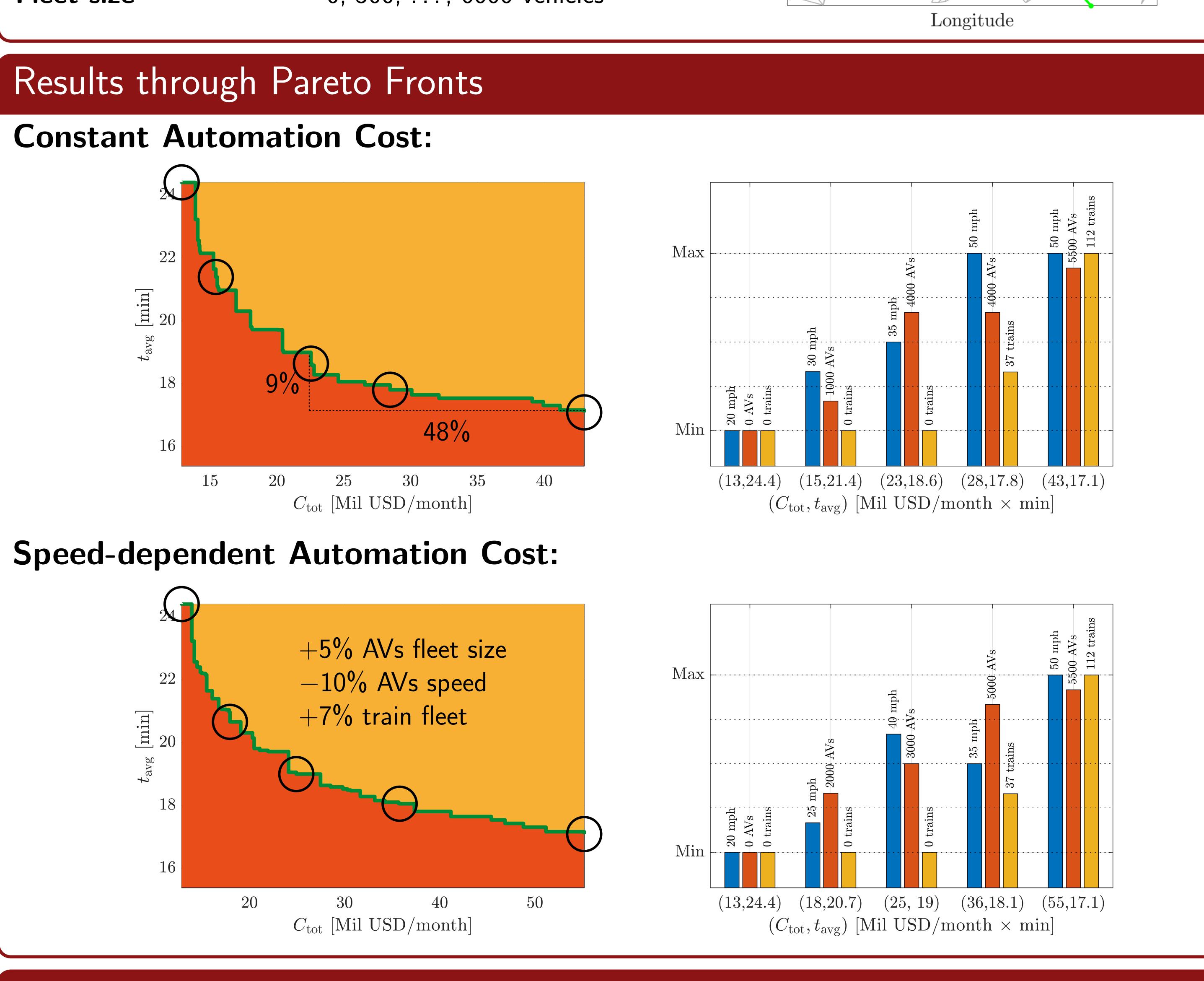
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Conclusions

- Co-Design framework for future mobility systems, modular, compositional, and readily extendable.
- New, different perspective. Useful for stakeholders such as AVs companies and policy makers.
- Future work: Extend to micromobility, model stakeholders' interactions, consider variable demand models.

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