

## Delay-compensating and coordinated traffic flow control Nikolaos Bekiaris-Liberis

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### Abstract:

Input delays are ubiquitous in vehicular traffic systems. On a macroscopic level, delays may be caused by long distances between actuated on-ramps and bottleneck areas, whereas on a microscopic level, delays may be due to actuators or sensors. If the delay effect is not taken into account, it may, in the former case, lead to congestion, whereas in the latter, it may jeopardize string (or even individual vehicle) stability, resulting in both cases to increased travel times and fuel consumption. I will present predictor-feedback designs for delay compensation in both cases--in the former, via introduction of a predictor-feedback ramp metering strategy for quasilinear transport PDE-ODE interconnections and, in the latter, by showing that predictor-based ACC laws may also guarantee string stability. I will further present control design ideas, which interlace PDE feedback linearization with PDE backstepping, for coordinated traffic flow control (via ramp metering or variable speed limits), introducing "bilateral" boundary controllers (i.e., considering actuation at both highway boundaries) and employing the cumulative number-of-vehicles model (an alternative to the conservation-of-vehicles equation) with drivers' look-ahead (giving rise to a viscous Hamilton-Jacobi PDE).



Nikolaos Bekiaris-Liberis received the Ph.D. degree in Aerospace Engineering from the University of California, San Diego, in 2013. From 2013 to 2014 he was a postdoctoral researcher at the University of California, Berkeley and from 2014 to 2017 he was a research associate and adjunct professor at Technical University of Crete, Greece. Dr. Bekiaris-Liberis is currently a Marie Sklodowska-Curie Fellow at the Dynamic Systems & Simulation Laboratory, Technical

University of Crete. He has coauthored the SIAM book *Nonlinear Control under Nonconstant Delays*. His interests are in delay systems, distributed parameter systems, nonlinear control, and their applications.

Dr. Bekiaris-Liberis was a finalist for the student best paper award at the 2010 ASME Dynamic Systems and Control Conference and at the 2013 IEEE Conference on Decision and Control. He received the Chancellor's Dissertation Medal in Engineering from the University of California, San Diego, in 2014. Dr. Bekiaris-Liberis received the best paper award in the 2015 International Conference on Mobile Ubiquitous Computing, Systems, Services and Technologies. He is the recipient of a 2016 Marie Sklodowska-Curie Individual Fellowship Grant.