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Traditional mobility management strategies primarily focus on macro-level traffic oversight, often neglecting the critical safety risks experienced by individual road users. This talk presents a novel system, the Digital Twin-based Driver Risk-Aware Intelligent Mobility Analytics (DT-DIMA), which bridges this gap by integrating mobility and safety analysis through advanced digital twin technology. The DT-DIMA system leverages real-time traffic data from pan-tilt cameras (PTCs) and synchronizes this data into a digital twin to accurately replicate real-world traffic conditions. Through the integration of advanced machine learning, simulation, and online control modules, the system provides network-wide predictions of mobility and safety risks in real time.

Key components of the system include a Spatial-Temporal Traffic Estimation module for real-time data fusion and traffic prediction, a Mesoscopic Traffic Safety Simulation framework for real-time safety risk assessment, and a Risk-Constrained Correlated Online Learning algorithm for adaptive PTC control. Evaluated in a simulated testbed for Brooklyn, New York, DT-DIMA demonstrated outstanding performance, with mean absolute percentage errors (MAPEs) ranging from 8.40% to 15.11% in traffic volume estimation and 0.85% to 12.97% in safety risk prediction. Moreover, its proactive PTC control enabled early detection of high-risk road segments, capturing potential traffic incidents with a 5-minute lead time.

DT-DIMA empowers transportation managers with an enhanced understanding of mobility and safety, enabling them to respond to incidents proactively and allocate resources efficiently. This talk will outline how this system can reshape traffic management by integrating mobility and safety into a unified framework, with the potential to improve road user experiences and prevent traffic-related incidents.