Given the ever-increasing scale and complexity of networked systems, e.g., in the context of smart cities, simulation-based methods must keep pace to ensure that the efficiency, security and safety of these systems can still be evaluated in a timely fashion. One branch of research on accelerating discrete simulations employs parallel and distributed hardware to exploit the concurrency present in the simulation models. Another branch focuses on eliminating unnecessary computations, often by reducing the level of modeling detail. This talk covers methods to accelerate discrete-event simulations of computer networks and agent-based simulations of road traffic. Approaches are presented to identify opportunities to predict future simulation states and thus to avoid ("fast-forward") costly intermediate computations. Further, several studies on the execution of discrete simulations on graphics processing units (GPUs) are presented, highlighting ways to address the respective challenges posed by discrete-event and time-stepped simulation on GPUs. Finally, a brief overview is given of current challenges and techniques in agent-based simulations using hardware accelerators.