Dynamics of Disruption and Recovery in Air Transportation Networks

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Abstract— Flight delays occur in the air transportation system when disruptive events such as weather, equipment outage, or congestion create an imbalance between system capacity and demand. These cycles of disruptions and subsequent recoveries can be viewed from a dynamical systems perspective: exogenous inputs (convective weather, airspace restrictions, etc.) disrupt the system, inducing delays and inefficiencies from which the system eventually recovers.We study these disruption and recovery cycles through a state-space representation that captures the severity and spatial impact of airport delays. In particular, using US airport delay data from 2008-2017, we first identify representative disruption and recovery cycles. These representative cycles provide insights into the common operational patterns of disruptions and recoveries in the system. We also relate these representative cycles to specific off-nominal events such as airport outages, and elucidate the differing disruption-recovery pathways for various off-nominal events. Finally, we explore temporal trends in terms of when and how the system tends to be disrupted, and the subsequent recovery.