Exponential stability almost surely for WADC with intermittent information transmission using stochastic time scale

Yichao Wang¹, Fatima Taousser², Seddik M. Djouadi³, Kevin Tomsovic⁴,
¹ The University of Tennessee, Knoxville

1 MOTIVATION, PROPOSED CONCEPT AND FRAMEWORK

Modern power grids are relying more on closed-loop controls with signals passed through communication networks. If any interruption of information transmission occurs, the system will act as a discrete time subsystem. Here for a wide-area damping control (WADC) example, an actuator or measurement signal will hold (remain constant) during a random time interval. Our stability condition allows us to better capture the systems hybrid behavior with less computational effort and greater precision.

2 STABILITY CONDITION: EXPONENTIAL ALMOST SURELY REGION

- Switched system with static-feedback control law

\[ x^{\Delta}(t) = \begin{cases} A_x x(t) & \text{for } t \in \bigcup_{i=1}^{m} \{ \tau_i(t), t_{i+1} \} \quad (\tau_i = 0) \\ A_x x(t) & \text{for } t \in \bigcup_{i=1}^{m} \{ t_{i+1} \} \\ x(t) = e^{A_x(t-t_0)}(l + p(t)A_x)e^{A_x(t_0-t_0)} \ldots (l + p(t)A_x)e^{A_x(t_0)}, t_0. 
\]

- Switched system with dynamic output feedback control law

3 CASE STUDY

- Study systems: SMIB/Kundur Two Area

- Region of exponential stability almost surely by following different distributions.
- State trajectories in case of stochastic time delay.
- Maximum allowable time delay: Case1(0.3246s), Case2(1.2635s)
- Dwell time delay: Case1(0.21s), Case2(0.61s)