This talk presents an effective, theory-based methodology for on-line transient stability assessment and enhancement of a large set of contingencies at operating points obtained from state estimators. Extensive evaluation of this methodology on a practical utility model as a fast screening has been performed. This evaluation study is the largest in terms of system size, 14,500-bus, 3000 generators, for a practical on-line TSA application. The evaluation results, performed on a total number of 5.3 million contingencies, were very promising in terms of speed, accuracy, reliability and robustness. This study also confirms the practicality of theory-based methodology for on-line TSA of large-scale power systems. In addition, on-line preventive control as well as enhancement control for transient stability of large-scale power systems will be also presented. Finally, a real-time, PMU-enhanced ATC system will be presented.