May 1997 Chilean Blackout

STABILITY ANALYSIS OF NONLINEAR SYSTEMS (EEEN50100)

Prof. Federico Milano

Email: federico.milano@ucd.ie

Tel.: 01 716 1844

Room 157a – Engineering & Materials Science Centre

School of Electrical & Electronic Engineering

University College Dublin

Dublin, Ireland

Chilean Blackout (11/07/2003)

- An example of an application of transient analysis techniques can be found in L.S. Vargas and C. A. Cañizares, “Time Dependence of Controls to Avoid Voltage Collapse”, *IEEE Transaction son Power Systems*, Vol. 15, No. 4, November 2000, pp. 1367-1375.
- This paper discusses the May 1997 voltage collapse event of the main power system in Chile.

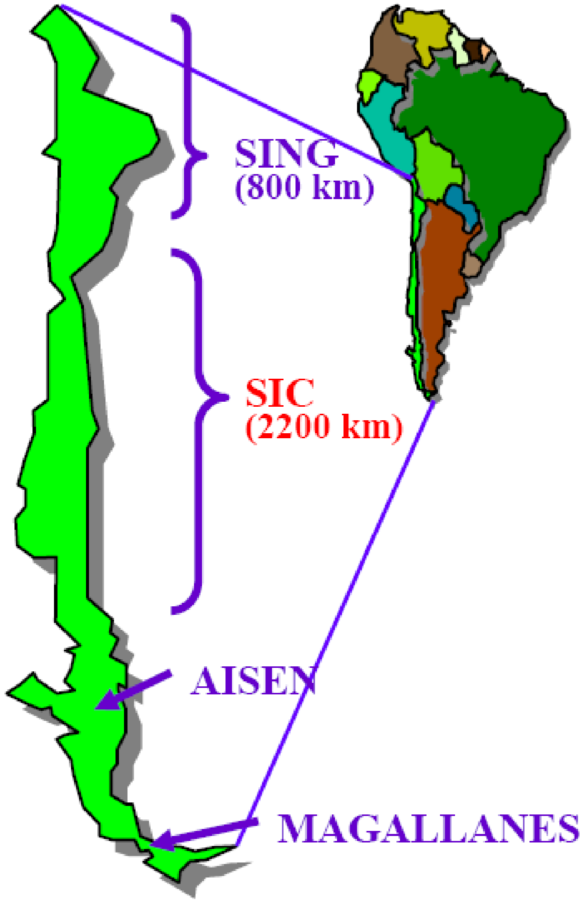
Chilean Blackout (11/07/2003)

- Most of Chile lost power in a major blackout on Friday evening, snarling rush hour traffic in the capital. The blackout began at about 7:20 pm, and power was back in about a third of the affected areas at 9:00 pm.
- At 9:00 pm lights were gradually coming on in parts of the capital, home to 5 million people or one third of the country's population. Television reports said power went out as far as Puerto Montt, a city some 600 miles south of Santiago, and in areas the same distance to the north.
- Source Reuters

Chilean Blackout (11/07/2003)

- Main system characteristics:
  - Extension: 756626 km^2.
  - Inhabitants: 14.5 mil.
  - National consumptions: 33531 GWh.
  - National peak load: 5800 MW.
  - Installed capacity: 8000 MW.
  - Frequency: 50 Hz.
  - Trans. Level: 66/110/154/220/500 kV.
  - Four interconnected systems: SING, SIC, AISEN, MAGALLANES

Chilean Blackout (11/07/2003)

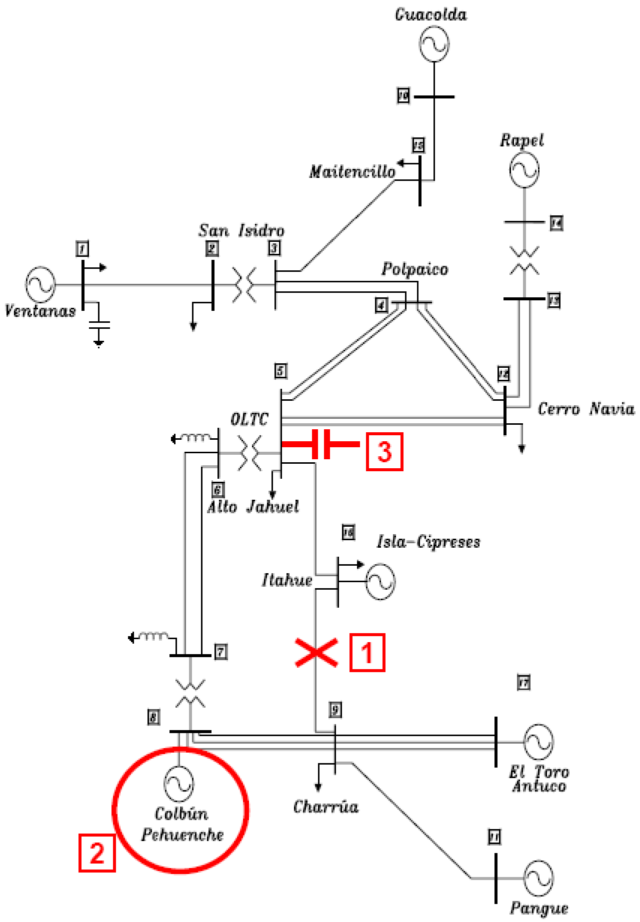


Chilean Blackout (11/07/2003)

- Initial state of SIC system:
  - 2500 MW load.
  - Power flow south-north near 1000 MW (900 MW through 500 kV lines and 100 MW through 154 kV lines).

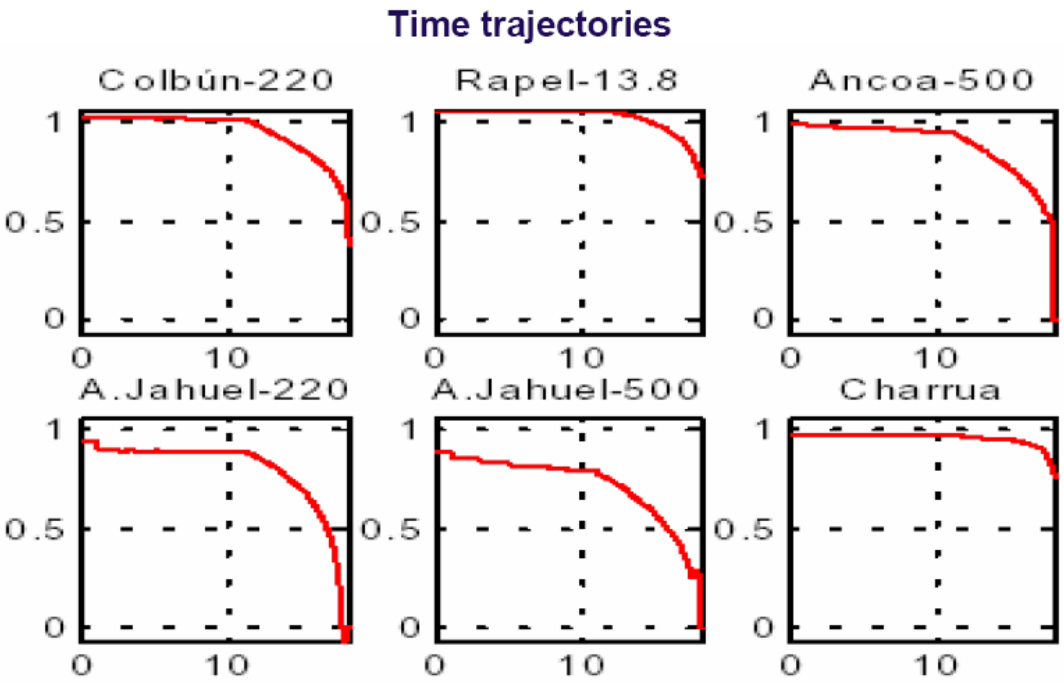
- Events:
  - Line 154 kV trips.
  - Major generator in the south hits reactive power limits and losses voltage control.
  - Operator tries to recover falling voltages by connecting a capacitor bank near Santiago.

Chilean Blackout (11/07/2003)



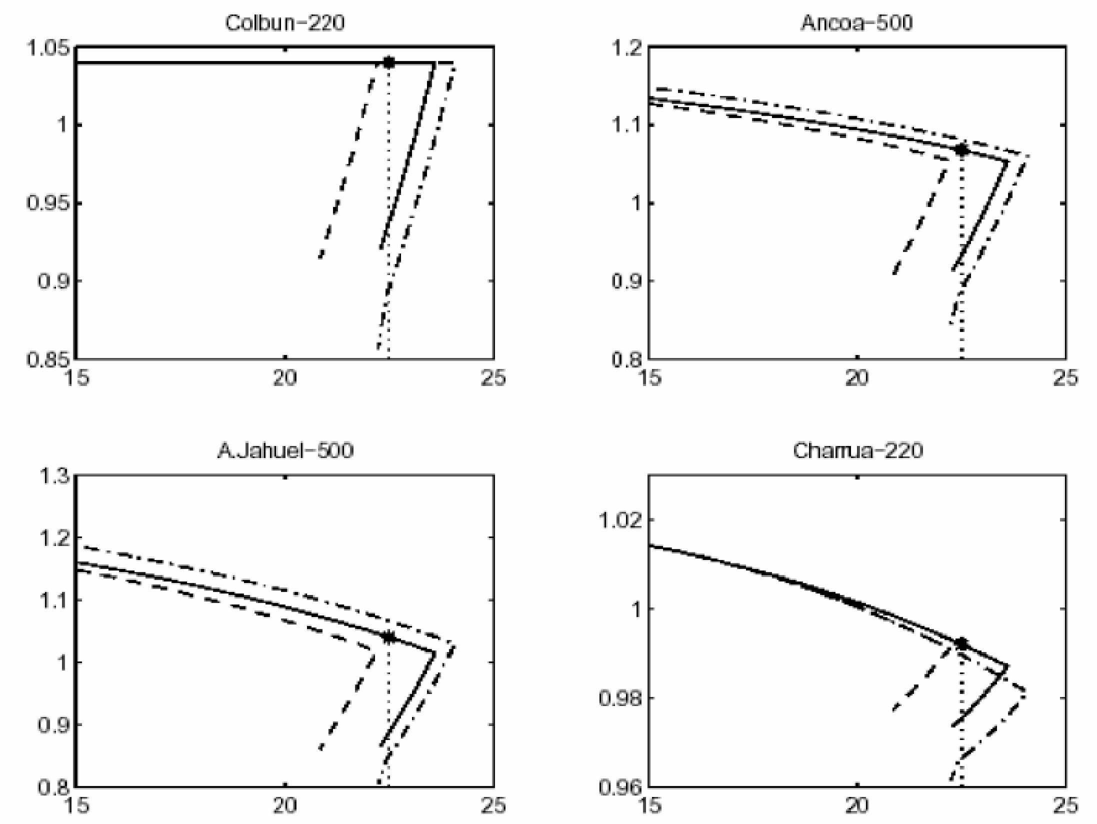
Chilean Blackout (11/07/2003)

- The line trip and generator limits yield a voltage collapse associated with a limit-induced bifurcation problem:



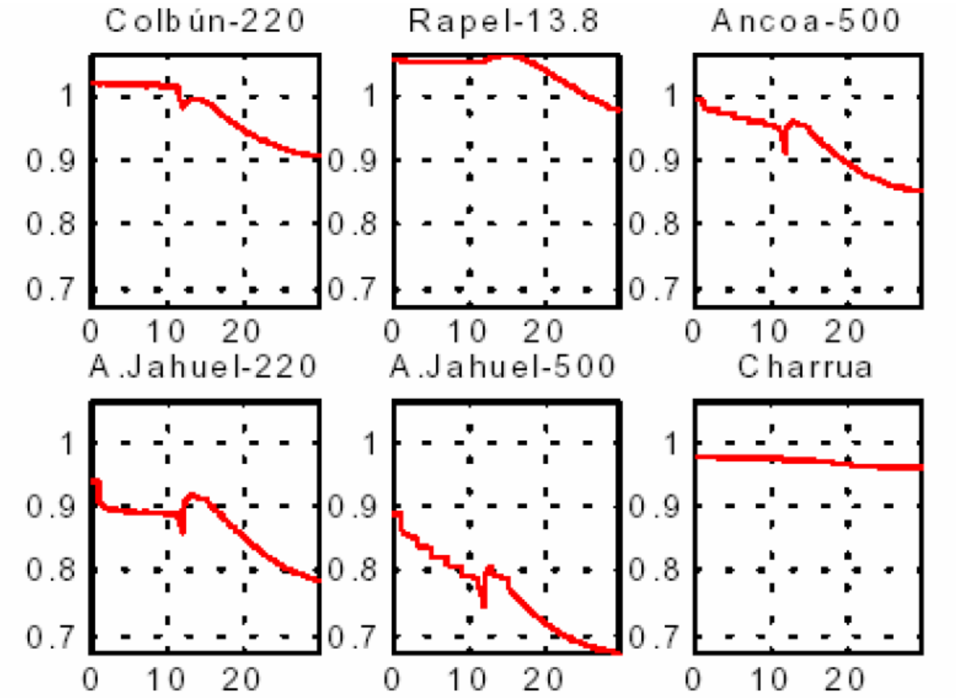
Chilean Blackout (11/07/2003)

- PV curves:



Chilean Blackout (11/07/2003)

- The connection of the capacitor bank after the generator limits are reached did not save the system, as the “faulted” system trajectories had “left” the stability region of the post contingency operating point.



Chilean Blackout (11/07/2003)

- If the capacitor bank is connected before the generator limits are reached, the system would have been saved, as the “faulted” system trajectories were still within the stability of the post-contingency operating point.