Effective Attacks against Power Grid Systems for Causing Cascading Failures

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Problem Statement

- Motivation:
    - 2005 Java-Bali blackout, affected 100 million people.
    - 2003 Northeast blackout, affected 55 million people.
- Cascading failures: The failure of a small set of components (e.g. substations, transmission lines) can triggers large scale failure in power grid systems.
- Goal: Understanding cascading failures; developing systematic approaches to identify most vulnerable network components.
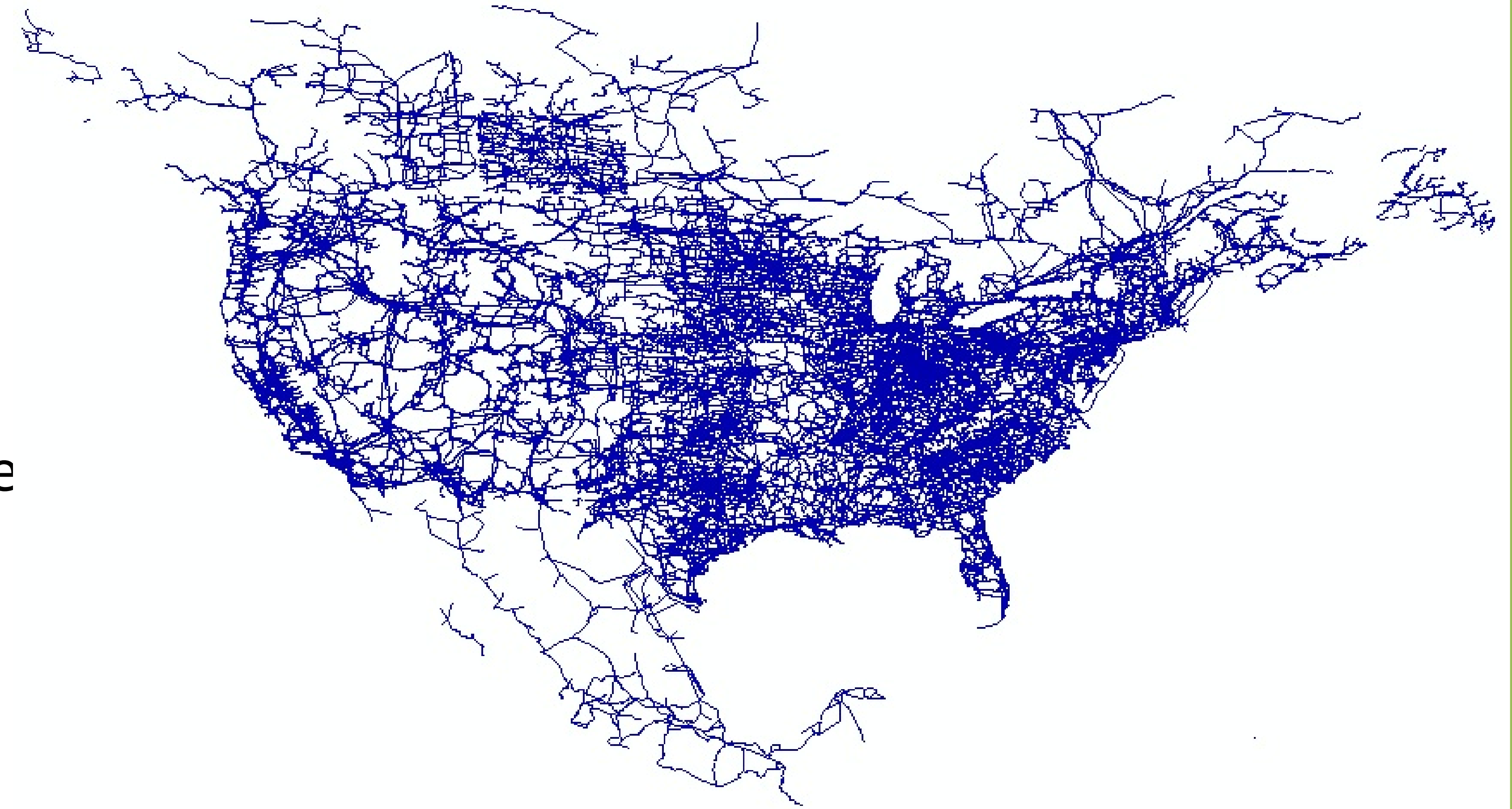

Fig. 1 The power grid of North American

System Models

- Network model
    - Weighted graph, **G**, to model the topology of power grid. Substations as nodes and transmission lines as links.
- Attack model
    - Removal of one or more substations/lines
- Load redistribution model
    - Load → Betweenness
    - Node/link failure → shortest path changes → overloading → link efficiency change → shortest path change → ...

Traditional Attack Strategies

- Selecting victim nodes based on the load
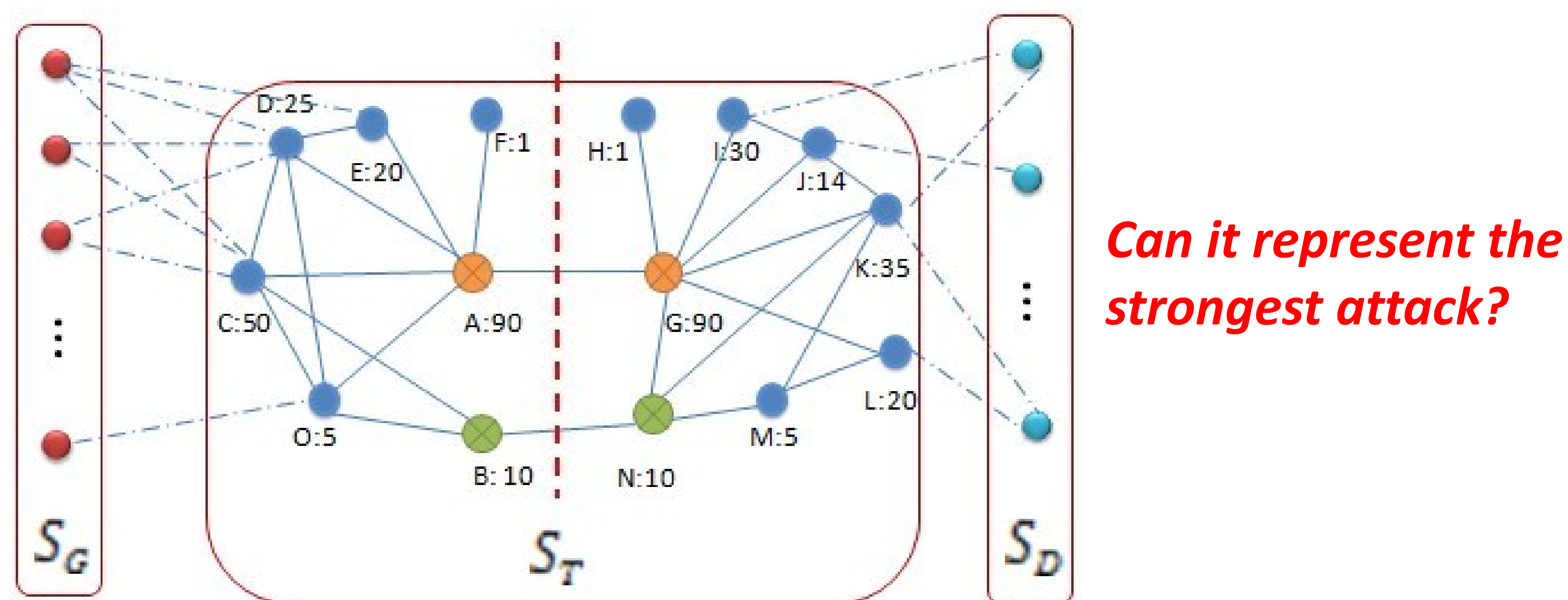

Can it represent the strongest attack?

Fig. 2 An example shows the limitation of load-based traditional attack strategy

- How to find the stronger attack?
    - Choosing critical nodes from different regions

Proposed Attack Strategy

- New metric: *feature vector (FV)*
    - The feature vector of node j is defined as the new load distribution of all nodes after removing node j.
    - Similarly, we can define the feature vector of link k.
    - Feature vectors can easily represent the different impact caused by removing different components in the grid, based on which nodes (or links) will be grouped.
- New attack strategies
    - Feature vector based multi-node attack strategy
    - Feature vector based multi-link attack strategy

Fig.3 Different attack scenarios

Simulation Results

- Testing data set: Western North American power grid network benchmark

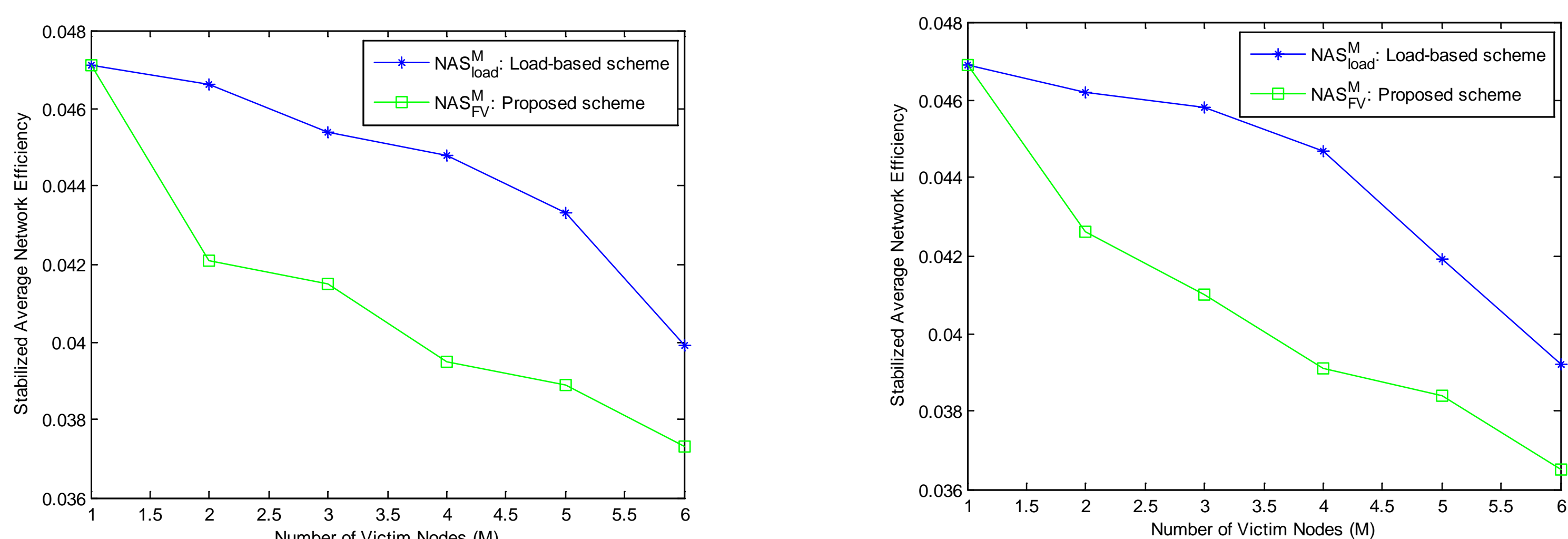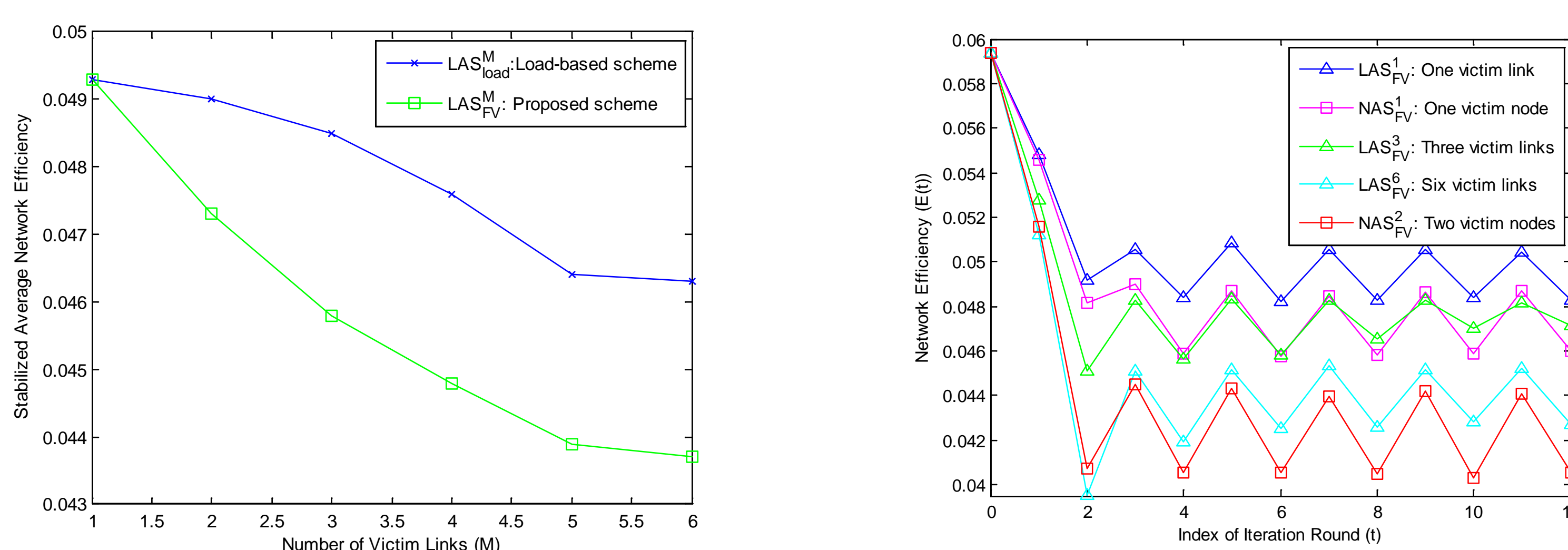Fig.4 Node attack strategies under snapshot 1 and snapshot 2
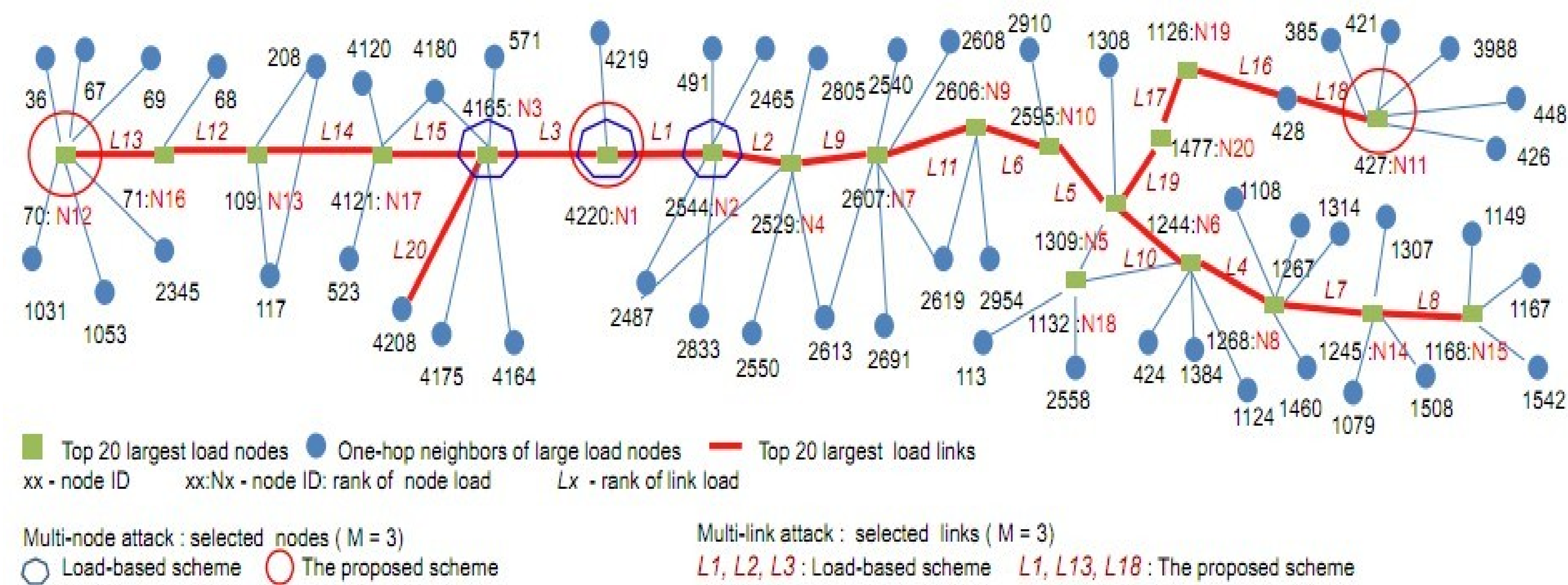

Fig.5 Link attack strategies

Fig.6 NSA vs LSA

Impact

- Understanding the vulnerability of power grid system from attackers' points of view
- Providing the new metric to describe impact of different components of the network
- Leading to joint investigation on node failure and link failure

THINK BIG WE DO