BA: What Can(not) Be Perfectly Rerouted Locally

- Critical network infrastructure has high availability requirements
- Hard real-time requirements on packet routing

⇒ How to provide dependability guarantee despite edge failures in networks?
⇒ Possible without communication between nodes?

Prior work: Impossible in general [PODC 2012, Feigenbaum et al.]
Model

• Network is a connected undirected graph $G = (V, E)$

• Forwarding at node $v$ may only match on:
  1. Destination $t$
  2. Incident edge failures $F \cap E(v)$
  3. Incoming port from $E(v) \cup \{\bot\}$

• No packet (header) changes allowed, no communication

• Static routing tables, deterministic behavior

• Goal: Install rules *ahead of time* to reach destination $t$
  under any edge failures $F$ (if connected)
Perfect Resiliency on Non-Planar Graphs? Impossible!

• Perfect resiliency on Graph \( G \) -> **Any subgraph** \( G' \) of \( G \) also allows for perfect resiliency
  ◦ Idea: Take routing on \( G \), fail edges to create \( G' \), routing must still work 😊

• **Contracting** works as well, by a simulation argument
  ◦ Essentially: Take perfectly resilient routing function, show that we can make it work after contraction

• Combined: Perfect resiliency on Graph \( G \) -> **Any minor** \( G' \) of \( G \) as well
  ◦ Definition: \( G' \) is minor of \( G \) if can be obtained by contracting/subgraphing

• We show \( K_5, K_{3,3} \) no perfect resilience -> **non-planar graphs do not allow for perfect resilience**
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• Perfect resiliency **impossible**:  
  ◦ On some planar graphs [already with just 7 nodes] and on all non-planar graphs

• Perfect resiliency **possible**:  
  ◦ On some planar graphs and on all outerplanar graphs

• In the extended version (link in paper):  
  ◦ Results on more powerful routing models, on rule space size, further open questions  

*Full version also appears at SIAM Symposium on Algorithmic Principles of Computer Systems [APOCS’21]*