Self-stabilizing (k,r)-Clustering in Wireless Ad-hoc Networks with Multiple Paths

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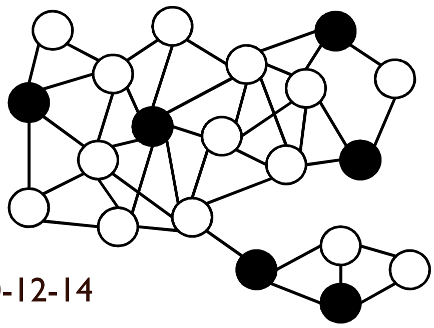
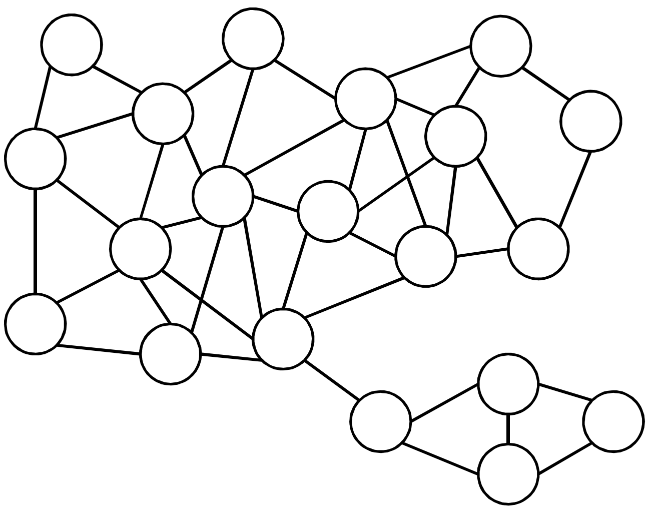
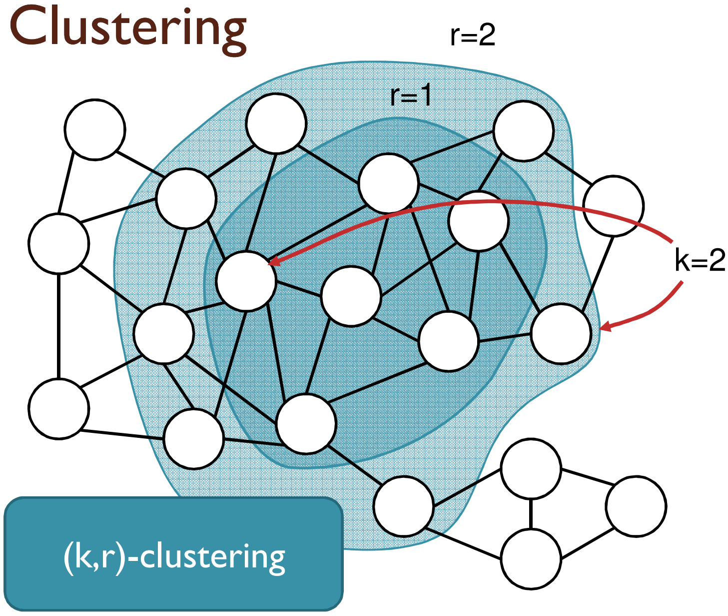


OPODIS 2010 – 2010-12-14

Ad-hoc networks



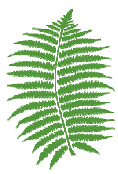
Clustering



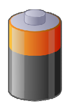
Uses of clustering

- Backbones
- Routing

- Scaling



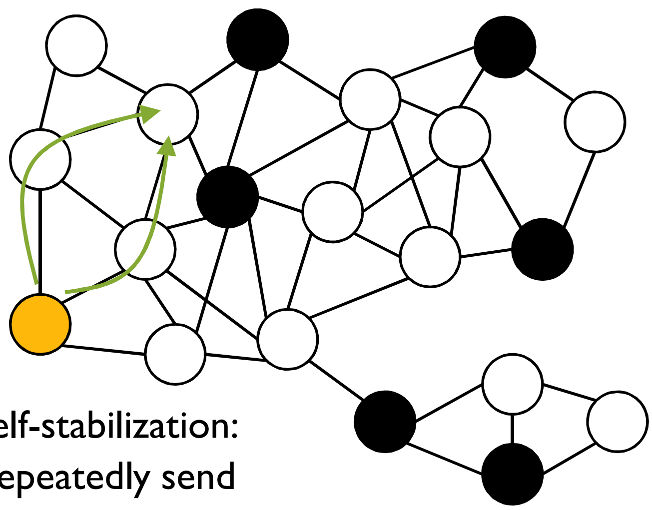
- Saving power



Self-stabilization

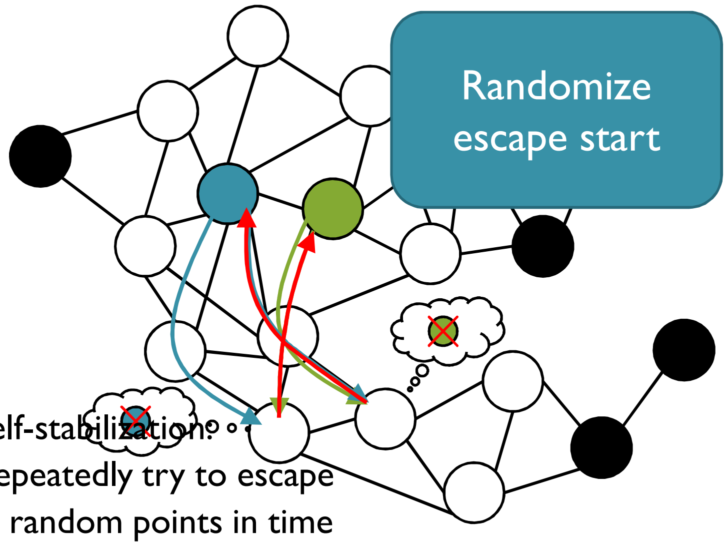
- Stabilize
  - From an arbitrary state to a consistent state
  - Once consistent, stay consistent
- Why needed?
  - Transient deviations from assumptions
  - Corrupted memory & messages

Our Algorithm – Deterministic joins



Self-stabilization:
Repeatedly send
ID, state & joins

Our Algorithm – Probabilistic leaves



Self-stabilization?
Repeatedly try to escape
at random points in time

Stabilization time – joins

Enough cluster heads within O(r) rounds

- Deterministic

- Knows neighborhood within r rounds
- Sends out "joins" that is received within r rounds

Stabilization time – local minimum

Local minimum within O(gr log n) rounds

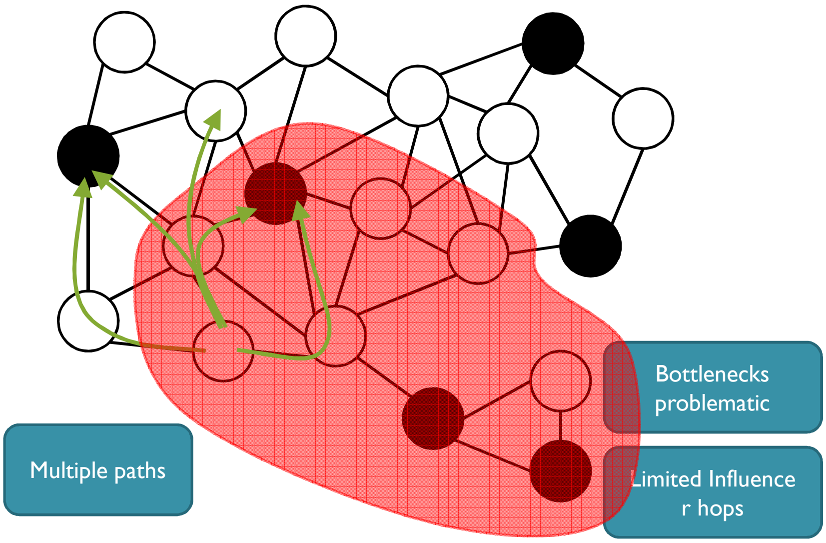
- g – possible number of nodes within 2r hops
- n – size of the network
- Probabilistic – w.h.p.

- g – number of potential interferers
- r – time to escape if uninterfered
- log n – ensuring the entire network converges

Multiple paths

- Multiple paths can improve
  - Security
  - Fault Tolerance
- We take advantage of them when they are present
- Malicious and faulty nodes can be bypassed

Malicious/faulty nodes



Ongoing and future work

- Coping quickly with topology changes
  - Initial results achieved
- Investigate and choose multiple paths
  - Investigate topology properties
  - Have nodes select paths to their cluster heads
- Investigate more security aspects
  - Attacks and countermeasures against the clustering algorithm

Conclusions

- First self-stabilizing distributed (k,r)-clustering algorithm

- (k,r)-clustering – redundance
- Multiple paths – withstand attacks/faults
- Self-stabilization – recover from transient faults

Thank you! Questions?

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