Select-and-Protest-based Beaconless Georouting with Guaranteed Delivery in Wireless Sensor Networks

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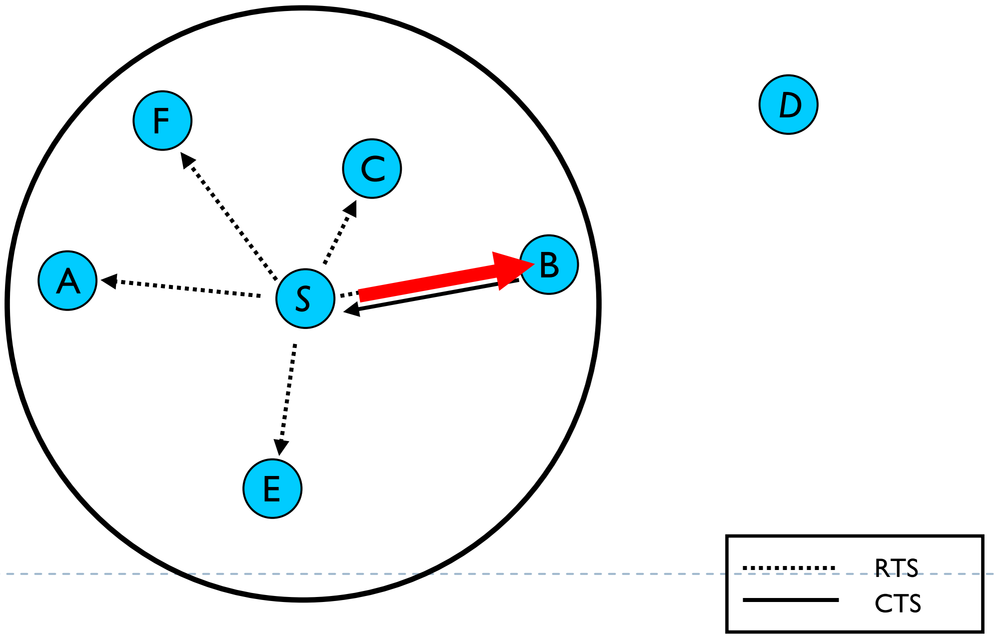
Outline

- Introduction
- Problem
- BFP Algorithm
- Properties of Proximity Graphs & Subgraph Construction
- Circlunar Neighborhood Graph
- Angular Relaying
- Simulation
- Conclusion

Introduction

- Beaconless Routing
  - avoid periodic exchange of beacon message
    - node is unaware of its neighbors

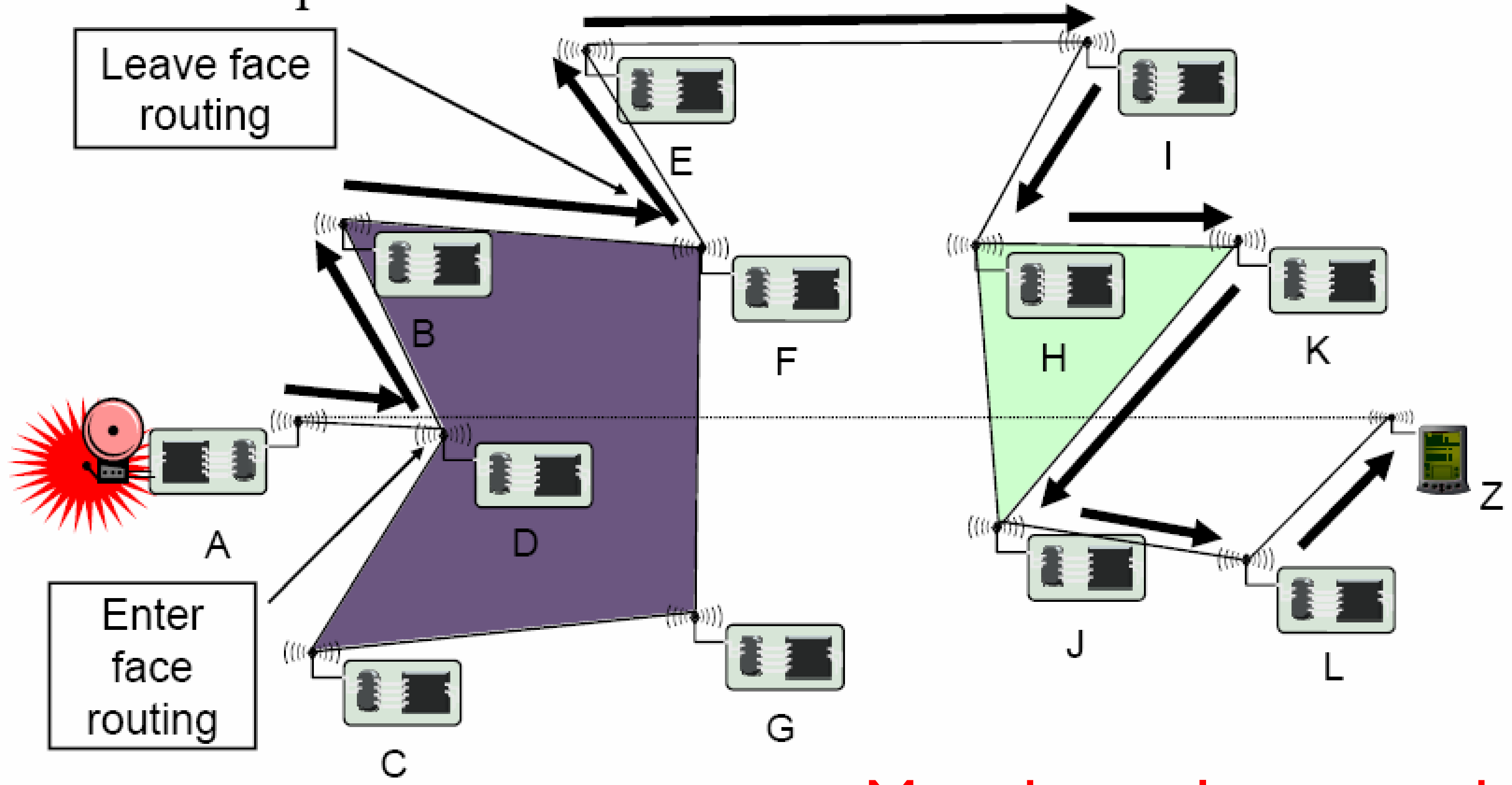


Introduction (cont.)

- Beaconless Routing with Guaranteed Delivery
  - greedy mode
    - use distance based timeout
  - recovery mode
    - select the neighbor of planar subgraph

Face routing

- Route packet from node A to node Z



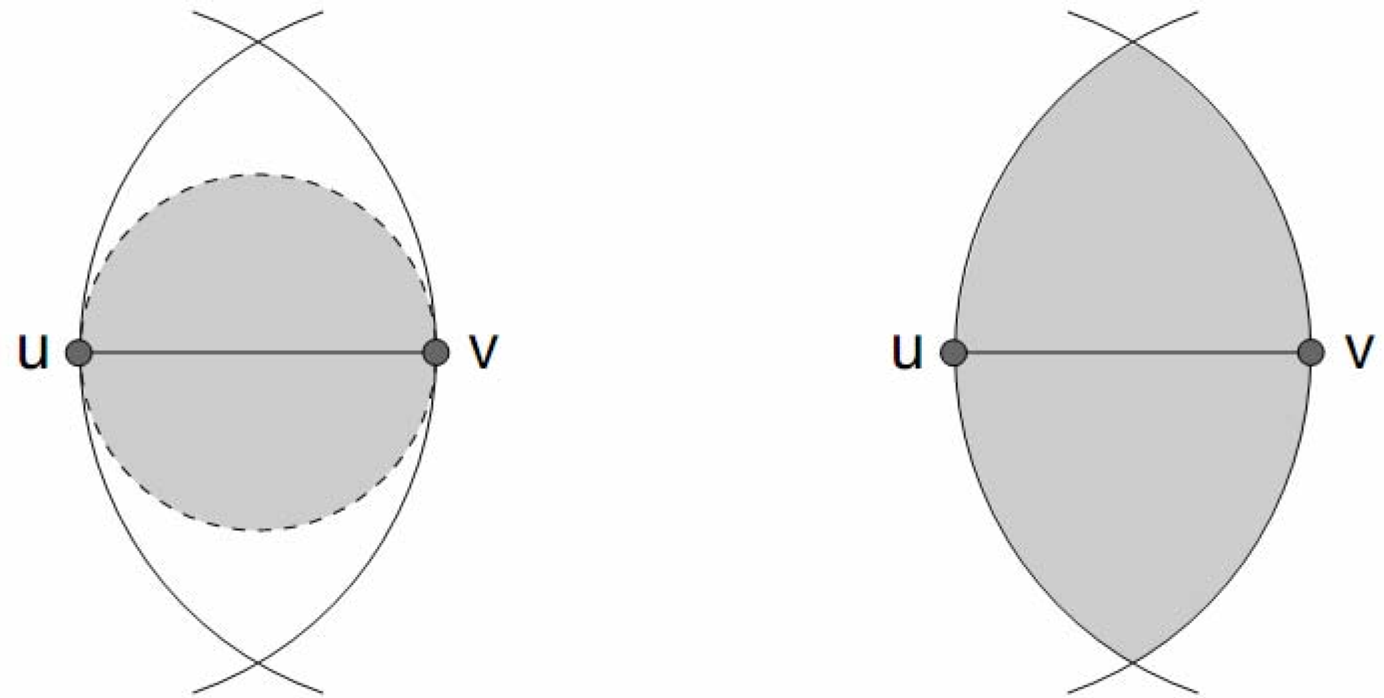
Must be a planar graph!!

Problem

- Recovery Problem
  - How to construct a local planar subgraph
    - BFP algorithm
  - How to determine the next edge of a planar subgraph traversal
    - angular relaying

Properties of Proximity Graphs & Subgraph Construction

- Consider only undirected, planar and connected proximity graph
- The proximity region of these graphs is symmetric, it contains at least Gabriel Graph(GG) circle and it is larger than the Relative Neighboehood Grapg(RNG) lune

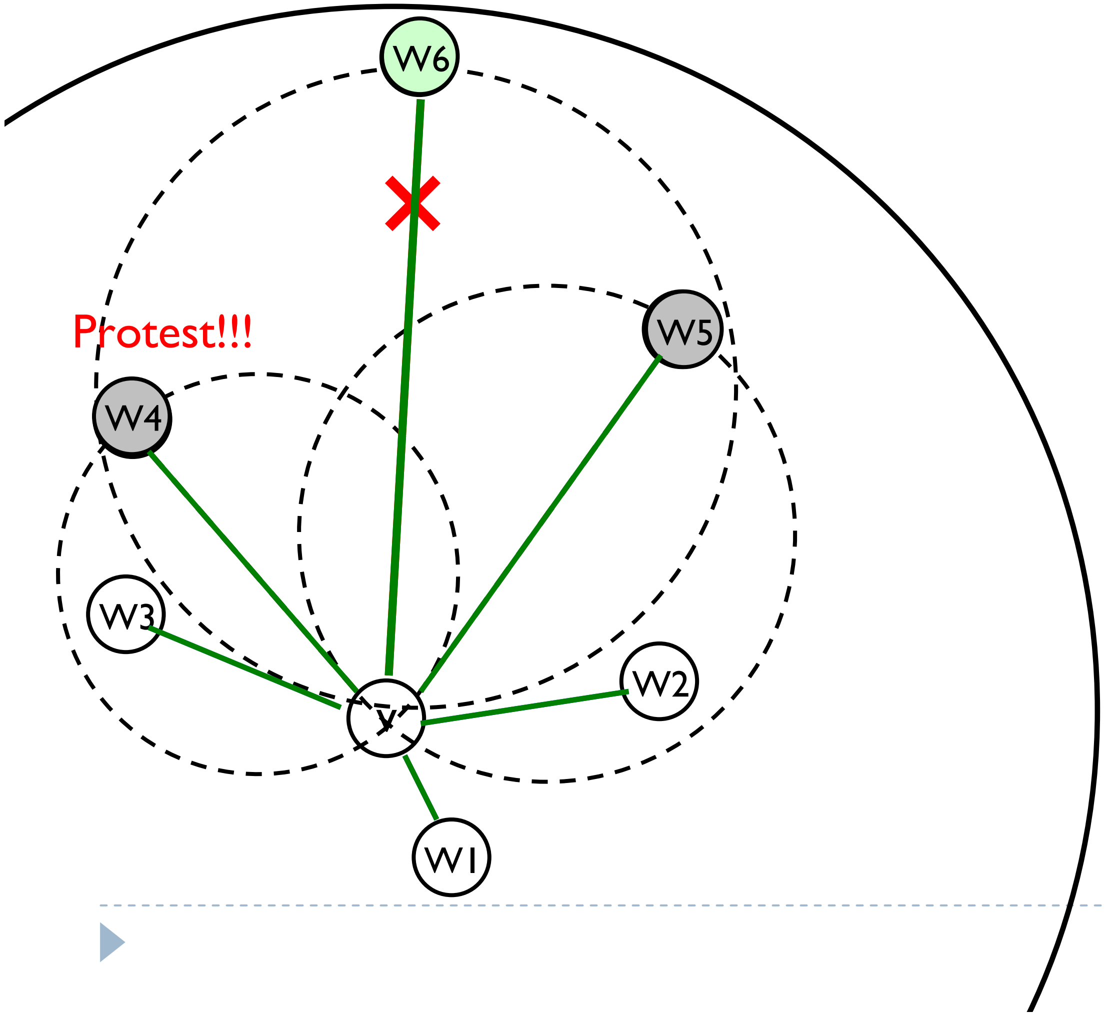


Proximity regions of GG and RNG

BFP Algorithm

- Beaconless Forwarder Planarization (BFP) is a general scheme, that can be used to construct different proximity graphs, such as Gabriel graph and RNG.

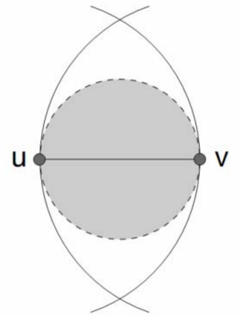
BFP Algorithm



- Select Phase
  - nodes respond to *S* based on distance to *S*
  - find neighbors of a planar subgraph
  - find hidden nodes & violating edge

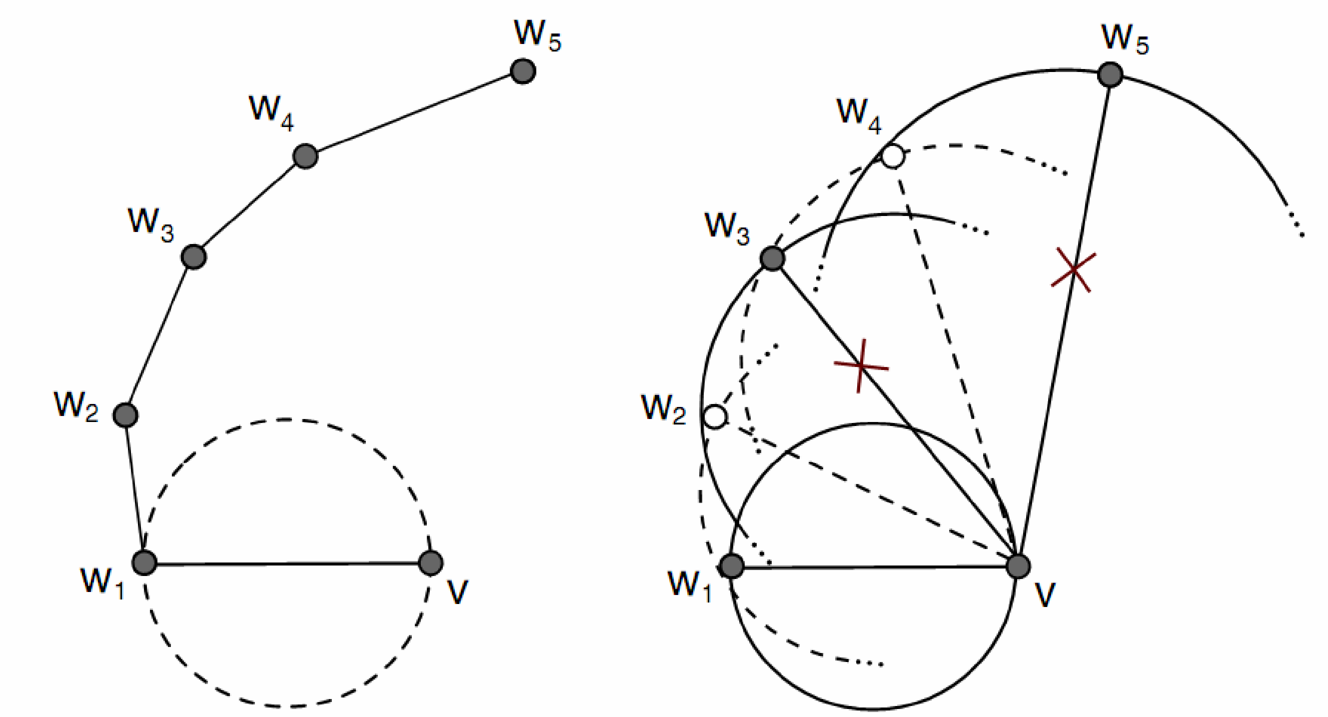
$$t(d) = \frac{|vw|}{r} \bullet t_{\max}$$

- Protest Phase
  - protest against the violating edge



Distance-ordered Neighborhoods

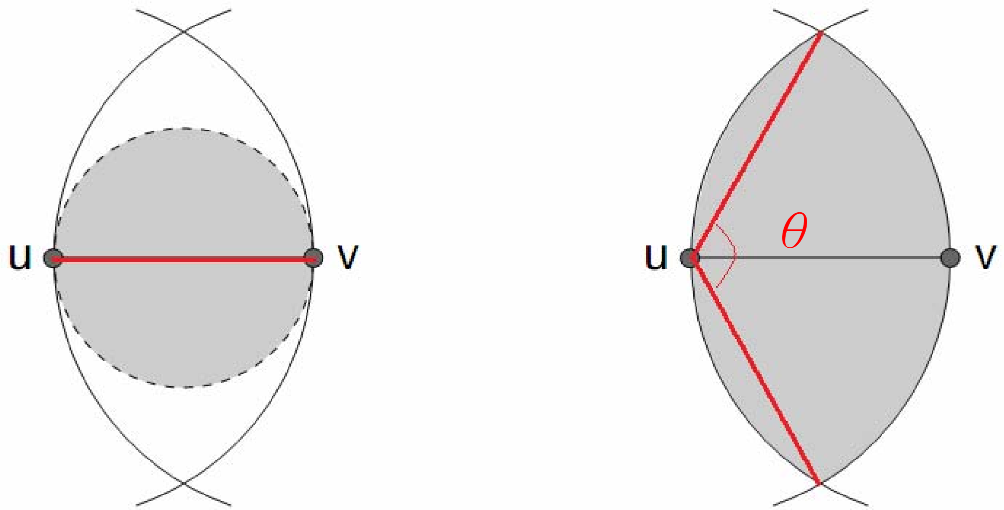
Theorem 2: A distance-ordered Gabriel neighborhood contains an unbounded number of violating edges.



Distance-ordered Neighborhoods (cont.)

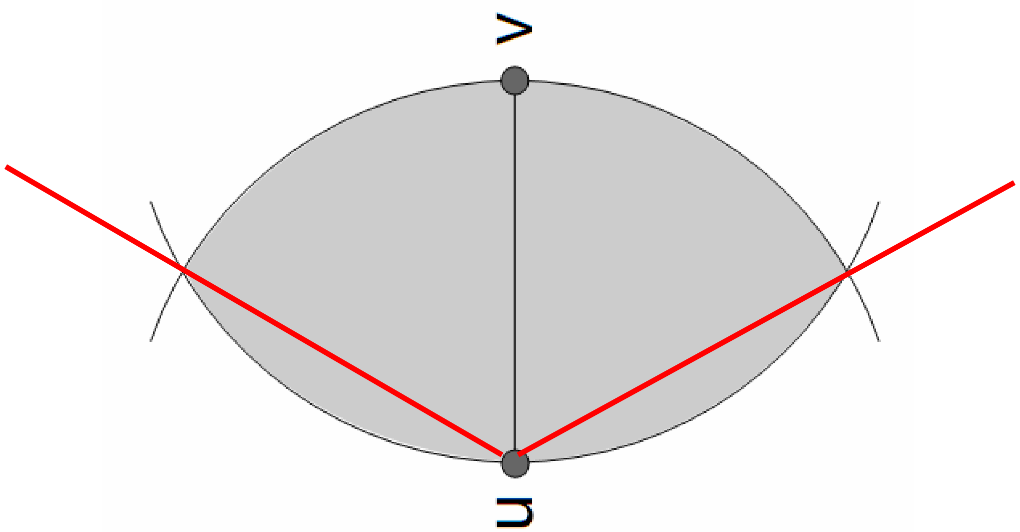
Theorem 3: If the proximity region contains a circular sector of angle θ, then

- the node degree at most $\lfloor 4\pi/\theta \rfloor$.
- a distance-ordered neighborhood has at most $\lfloor 4\pi/\theta \rfloor - 1$ violating edges.

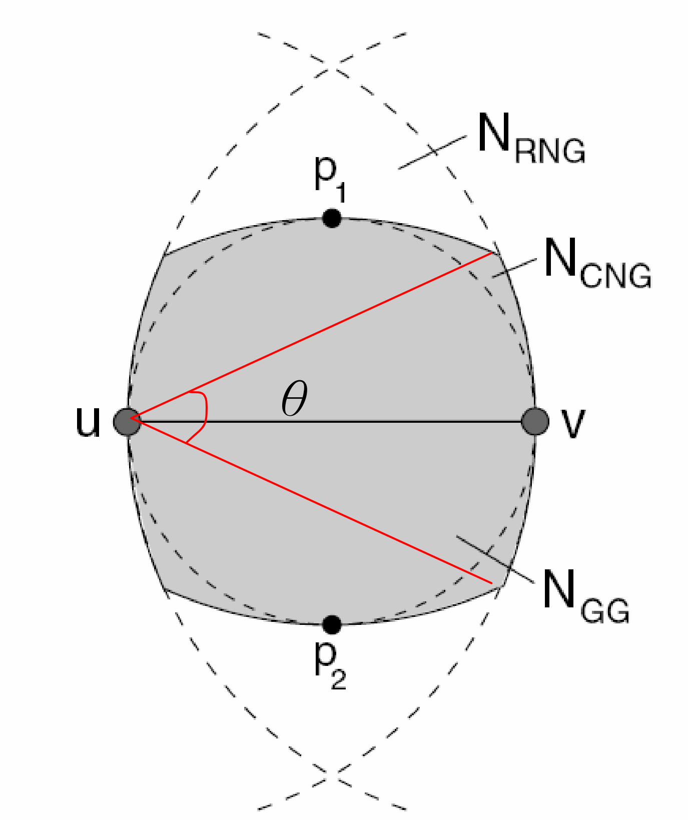


Distance-ordered Neighborhoods (cont.)

Theorem 4: A distance-ordered relative neighborhood contains at most 4 violating edges.



Circlunar Neighborhood Graph



$\Theta = 48.6^{\circ}$

$N_{CNG}(u, v)$ with RNG lune and Gabriel circle

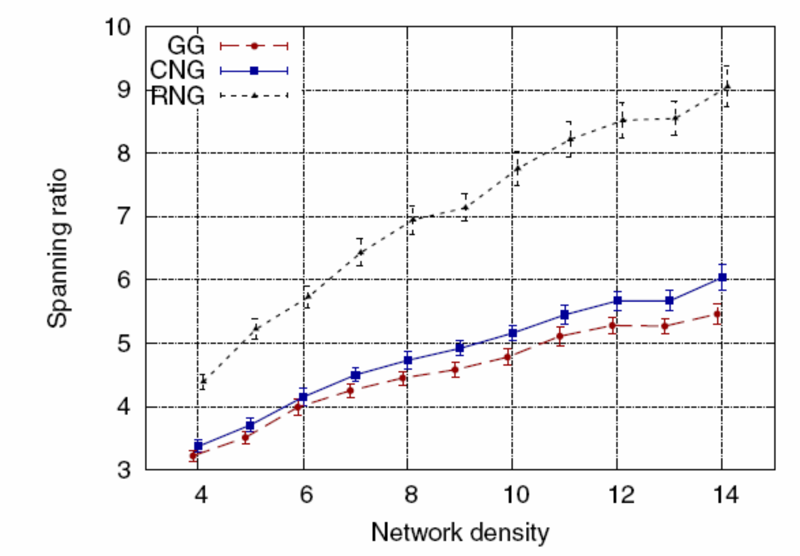
Properties of CNG

- 200 random unit disk graph with 100 nodes
- network densities between 4 and 12

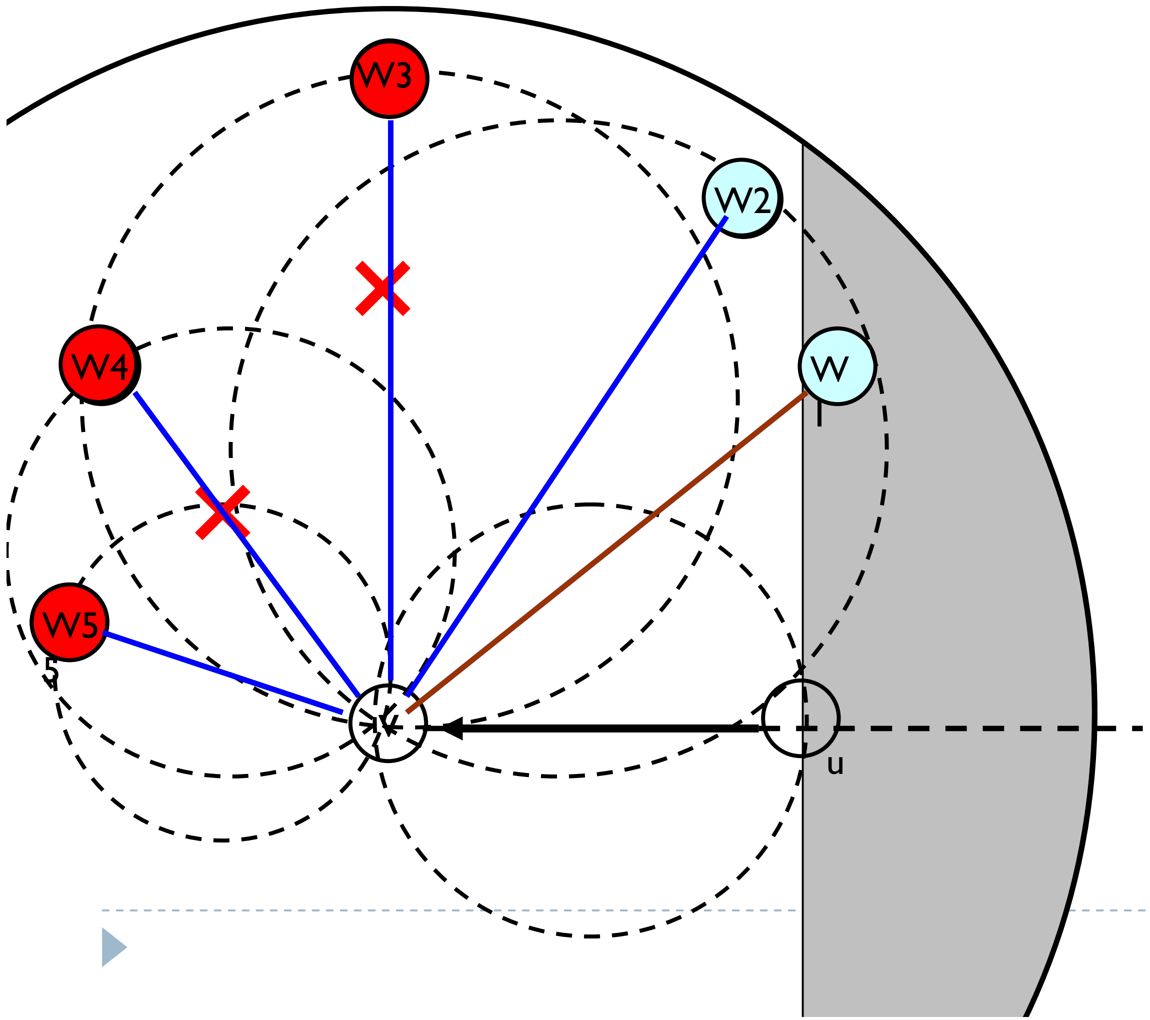
選到較差的路

Graph	Exp. degree [9]	Max. degree	Spanning ratio [2]
RNG	2.558	5	$\Theta(n)$
CNG	3.598	14	$\Theta(n)$
GG	4.000	$n-1$	$\Theta(\sqrt{n})$

TABLE II: Properties of RNG, CNG and GG



Angular Relaying



- Select Phase
  - All nodes allow to respond to *S* based on angular distance to *S*
  - no hidden node

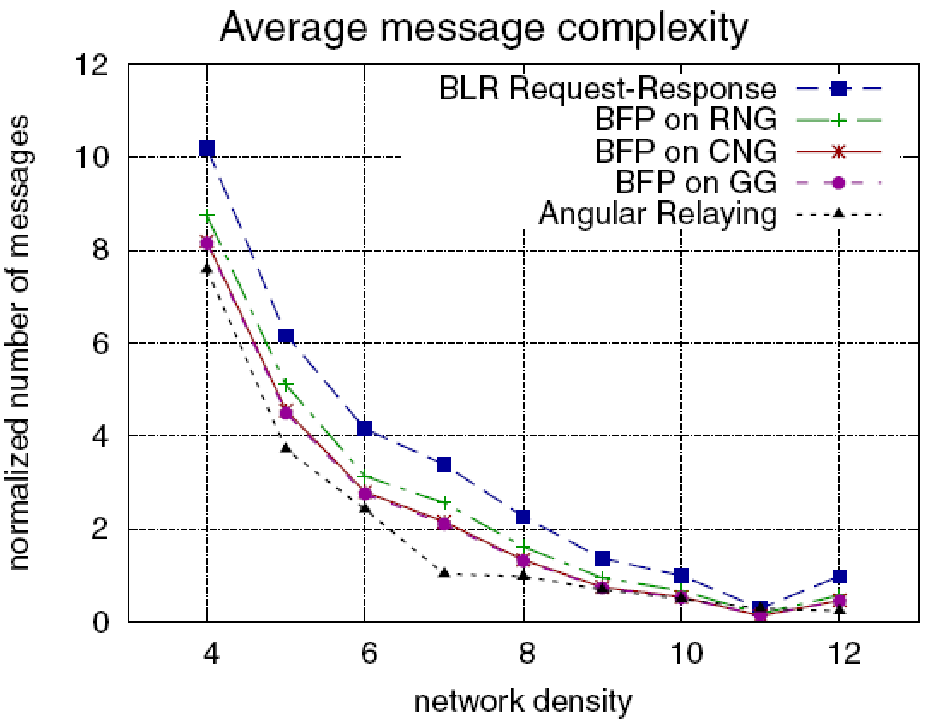
$$t(\theta) = \frac{\theta}{2\pi} \bullet t_{\max}$$

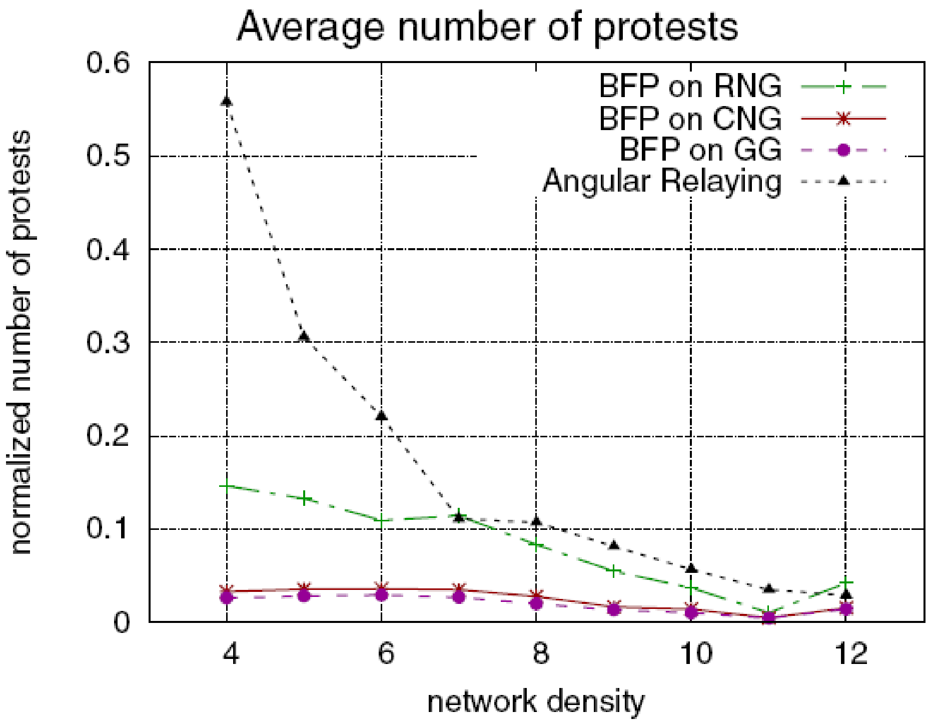
- Protest Phase
  - protest against the current candidate node

Simulations

- 500 random graphs with 100 nodes
- Network densities from 4 to 12

Simulations





Conclusion

- Proposed two solutions for beaconless recovery problem
  - BFP algorithm
  - Angular relaying

- Proposed Circlunar Neighborhood Graph(CNG)