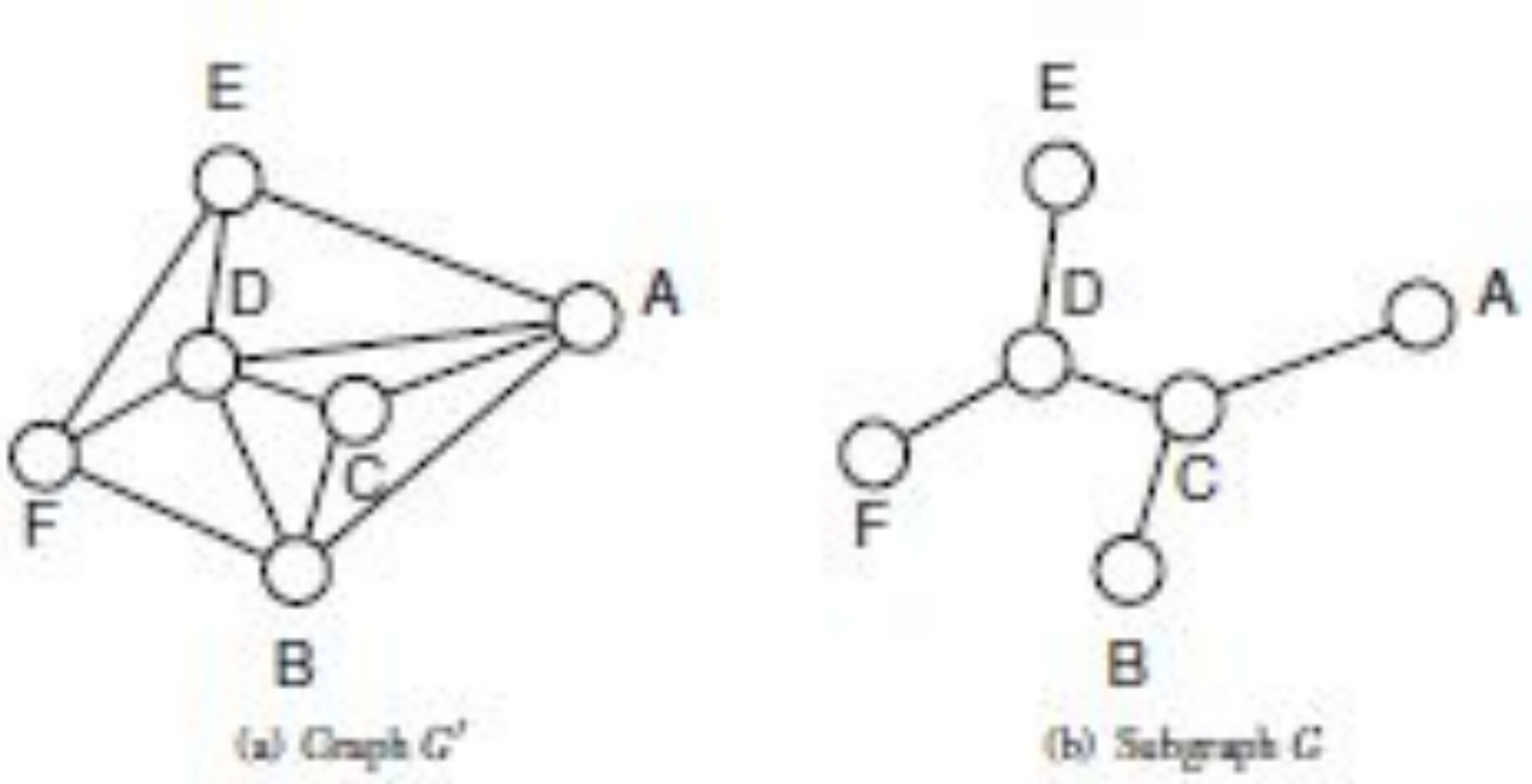
Geographical routing protocols

- Some applications need nodes locations
  - “ Any node in this location”, “location of temp >50 deg
- GPS devices can be used
- Localization algorithms exist
- The location information can be used for routing

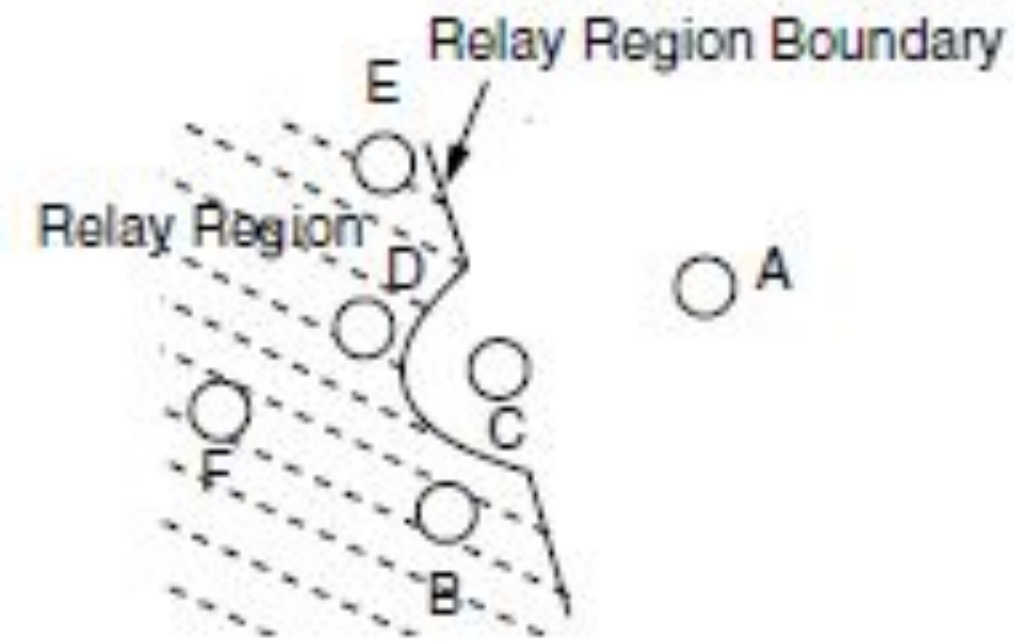
Minimum Energy Communication Network (MECN)



(a) Graph G' (b) Subgraph C

Minimum Energy Communication Network (MECN)

- Relies on localized search for each node through a relay region concept
- $P(A,B)=t*d(A,B)^n$, $n>=2$.

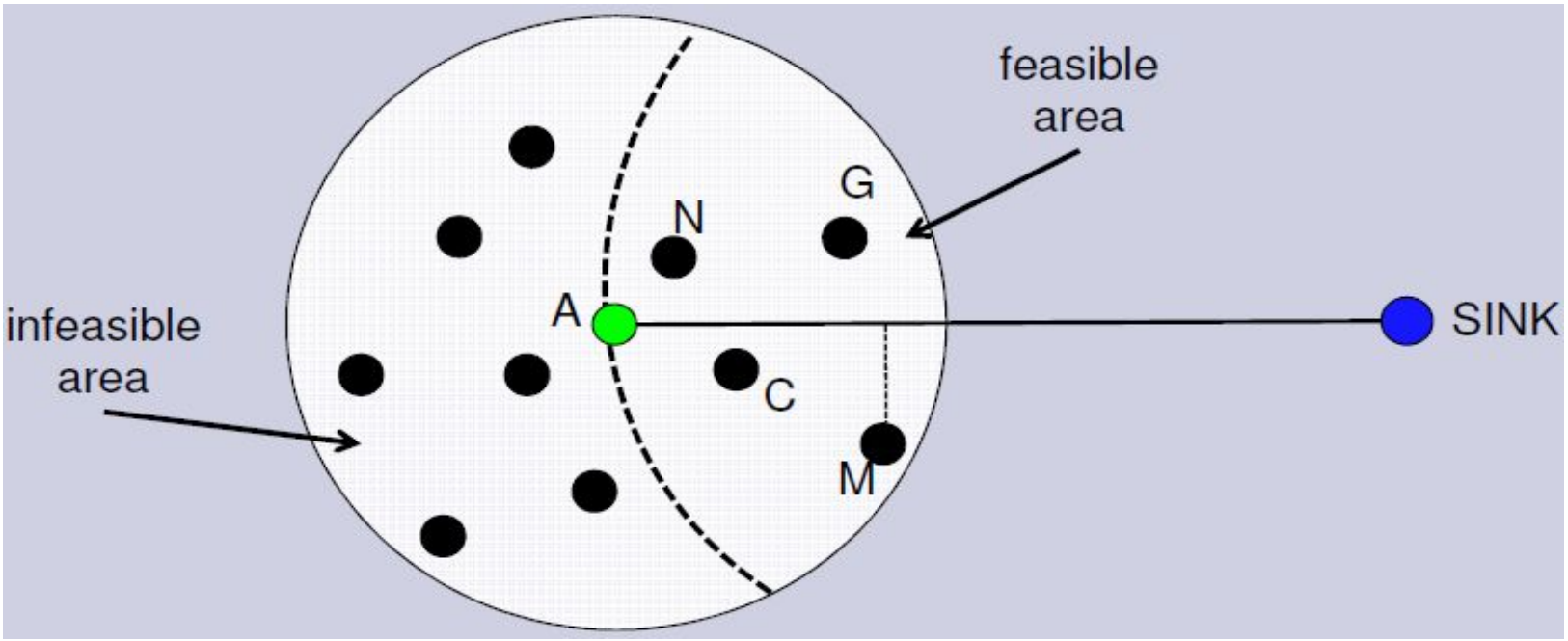


Greedy Forwarding

- Because of failures, network graphs formed by algorithms may change => reconstruct

- Use localized algorithms such as Greedy Algorithms that selects the *closest* node to the sink

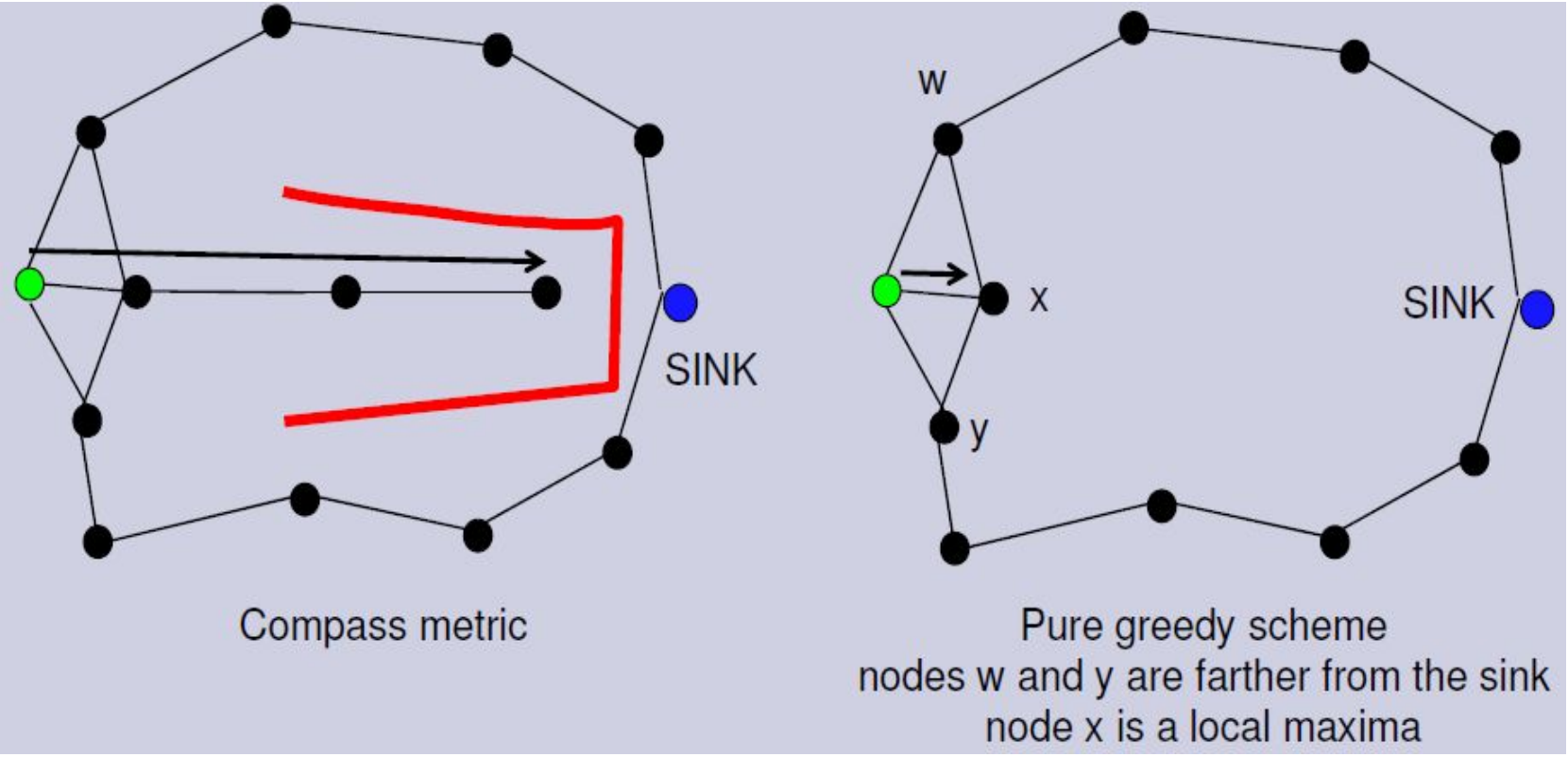
Greedy Forwarding



- *Closest node:*

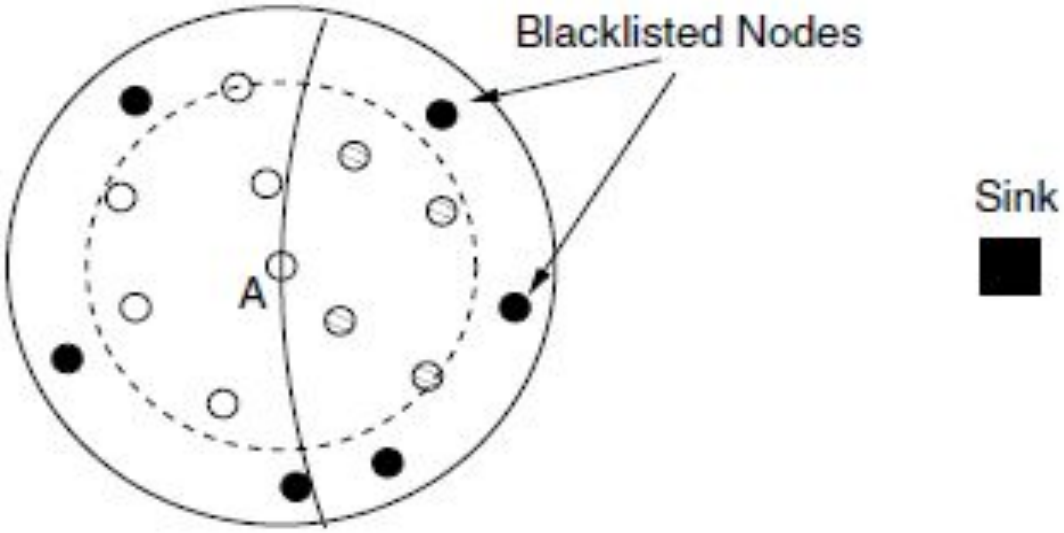
M → **most forwarding within radius**; node with the largest advancement on the straight line connecting A and sink
N → **nearest forward progress**; closest node to the source
G → **pure greedy scheme**; node that is closest to the destination
C → **compass metric**; node that is closest to the straight line connecting A and sink

Greedy Forwarding failures



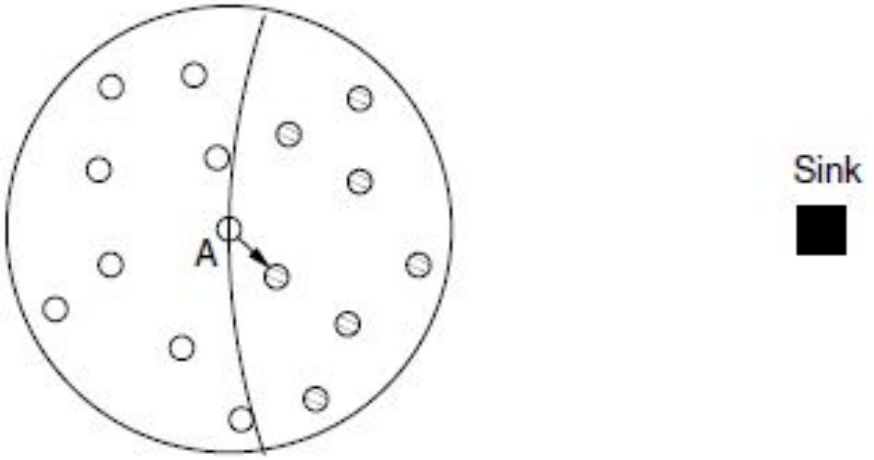
Greedy Forwarding

- In addition to location, channel quality is also important
- Closest nodes may decrease the number of hops, however, retransmission may be required to deliver messages to those nodes
- Distance based blacklist



Greedy Forwarding

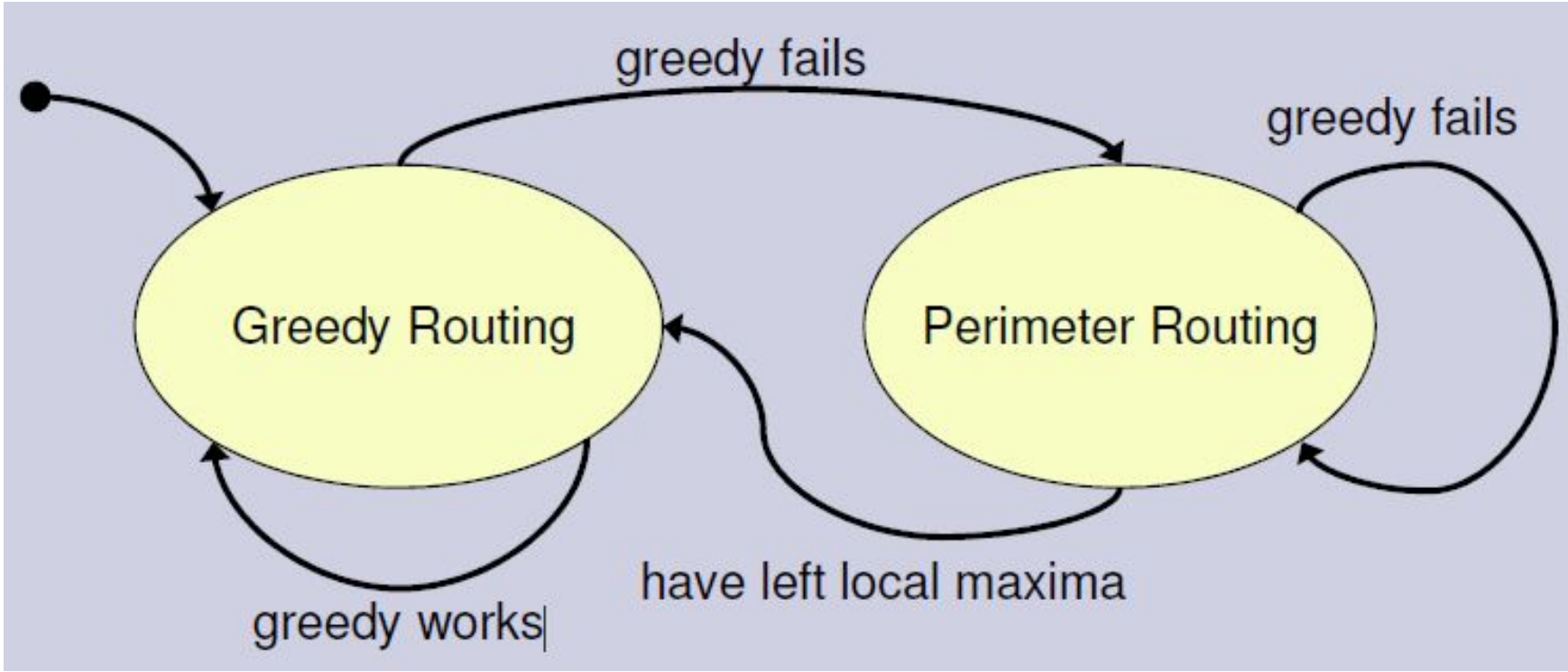
- Distance based blacklisting does not always say the channel quality
- Reception-based blacklisting
- Packet reception rate (PRR) may be used
- *Best reception neighbor* algorithm



Greedy Perimeter State Routing (GPSR)

- Uses node locations and packet destinations to make forwarding
- Based on greedy forwarding and perimeter forwarding
  - When greedy forwarding fails, switch to perimeter forwarding

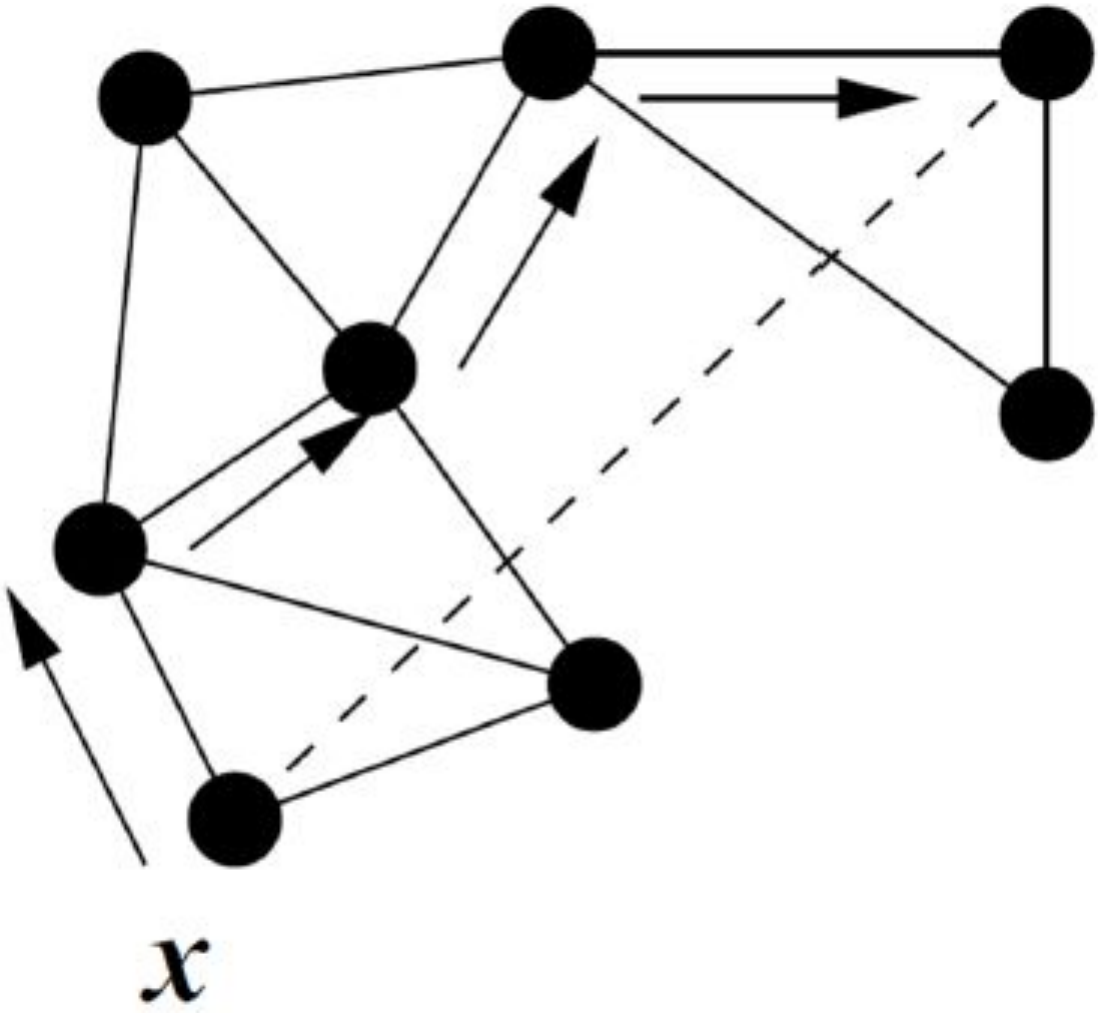
GPSR


greedy fails
greedy fails
Greedy Routing
Perimeter Routing
have left local maxima
greedy works

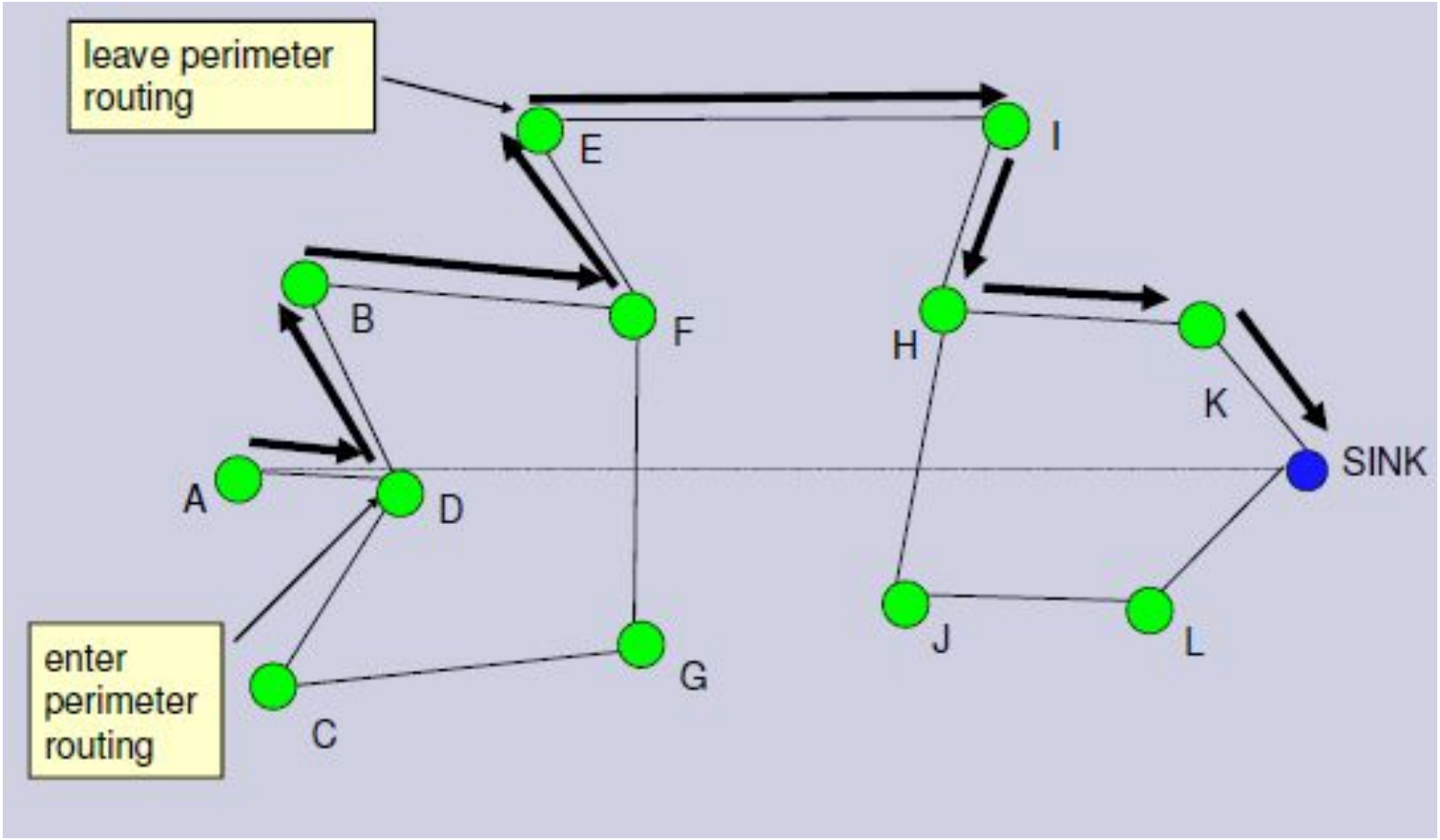
Perimeter routing in GPSR

- The right-hand rule
  - When arriving at *x* from *y,* the next edge is the next one sequentially counter clockwise about *x* from edge (y,x)
- The right hand rule is used until reaching an edge that crosses $\overline{sd}$. At that point we move to the next.

Perimeter routing in GPSR

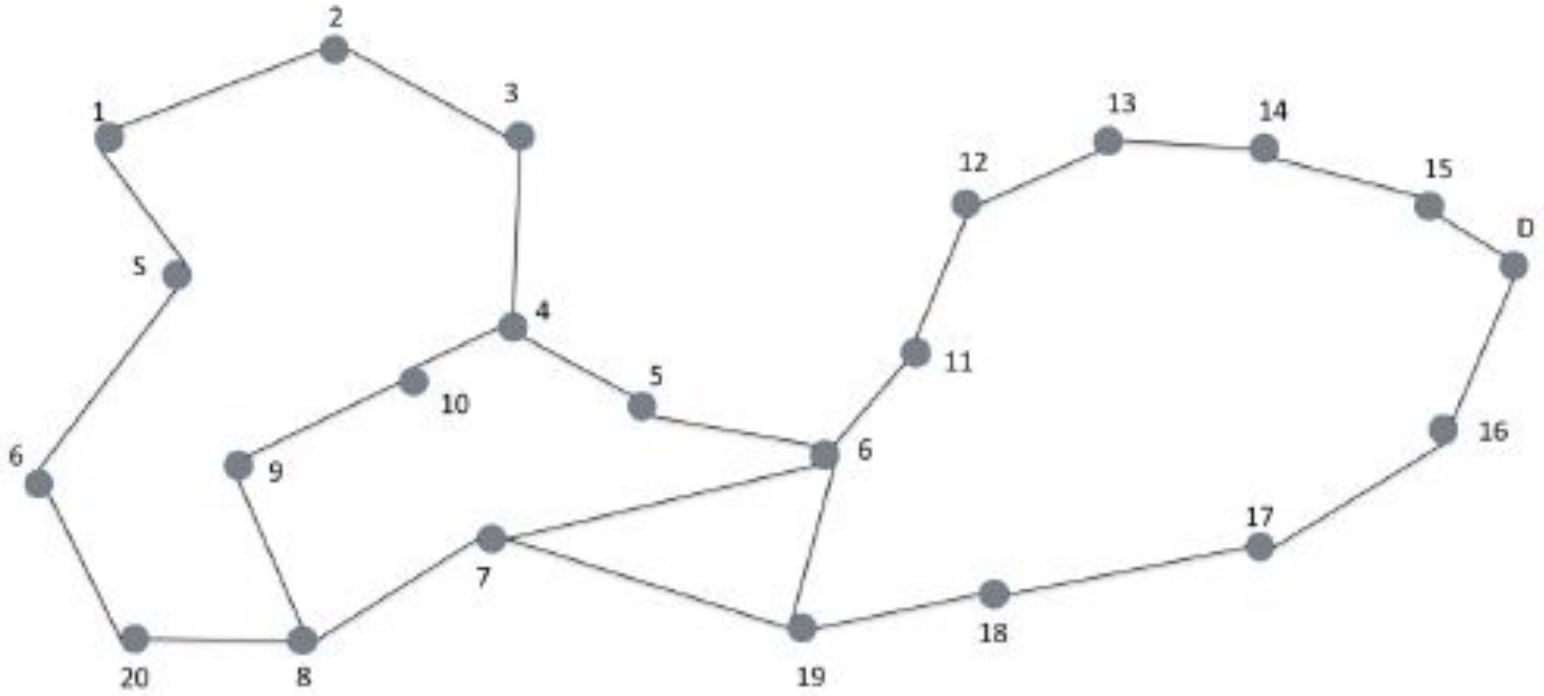


GPSR


leave perimeter routing
E
I
B
F
H
K
SINK
A
D
J
L
enter perimeter routing
G
C

Problem

Show the routes taken by Greedy Routing, Perimeter Routing and GPSR in the WSN depicted in Fig. 2, where S is the source and D is the destination. After the traversal of an edge (u,v), select as the next edge of the face traversal the first edge after (v, u) in clockwise order around v.



QoS based routing

- Consider other QoS metrics such as delay, throughput
- Minimum Cost Path Forwarding

Minimum Cost Path Forwarding

- Combines the delay, throughput and energy usage characteristics of the network to establish routes to the sink
  - a cost is assigned to each link that reflects the delay, throughput and energy consumption
  - a cost field is computed at each node in a distributed manner
  - packets flow through the nodes with the lowest cost
- Comprises two phases:

1	2
Cost field establishment Costs to forward data to the sink are computed for each node	**Data dissemination** Data are sent to the sink over the optimal route

Minimum Cost Path Forwarding

1. Sink broadcast and ADV packet with cost 0; i.e., own cost

2. Node N receiving an ADV from node M updates cost to:

$$\min(L_N, L_M + C_{NM})$$

L_N is the cost of N to sink, if no route is available to sink, the cost is ∞
L_M is the cost of M to sink
C_{NM} is the cost from N to M

3. If L_N is updated, node N broadcasts the updated cost using an ADV with a back-off time of $\gamma \times C_{NM}$, where γ is a constant

Minimum Cost Path Forwarding