# Geo-Routing
Beaconless routing – Contention-based

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Overview

- Neighborhood-based
  - Each node must know their 1-hop neighbor's position
  - Next hop decision is computed locally
  - GPSR, BoundHole, …
- HELLO message
  - Construct NeighborTable

Broadcast position

Send back position
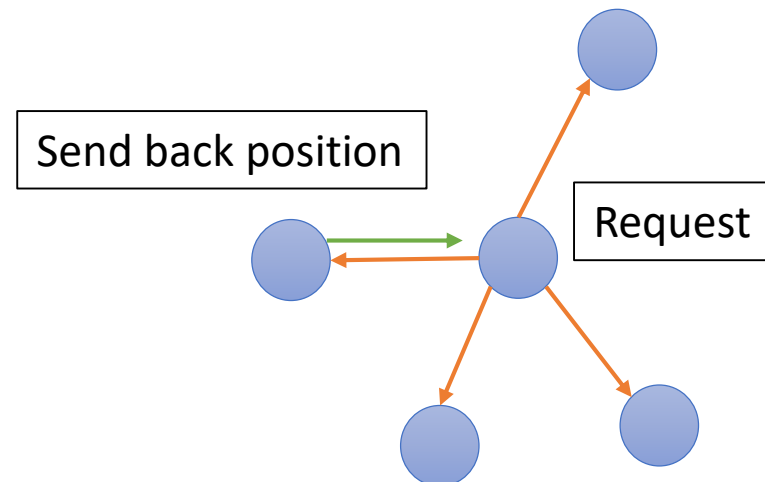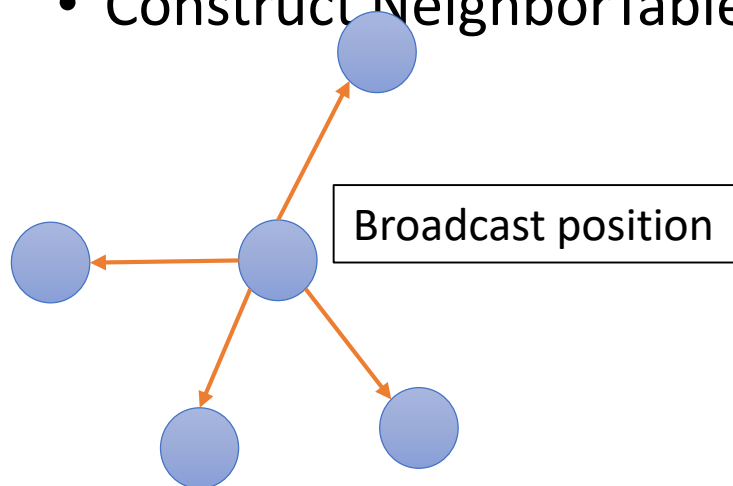
Request

Overview

- Hello message scheme
  - Request on routing
  - Broadcast periodically

- Advantages

- Disadvantages
  - Need more energy for broadcast position information
  - Locally computation
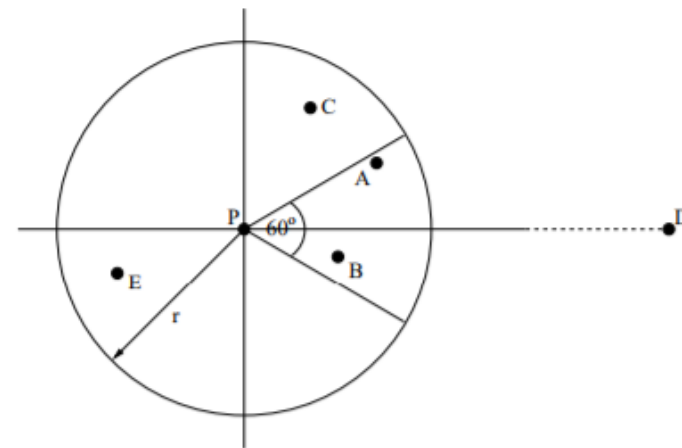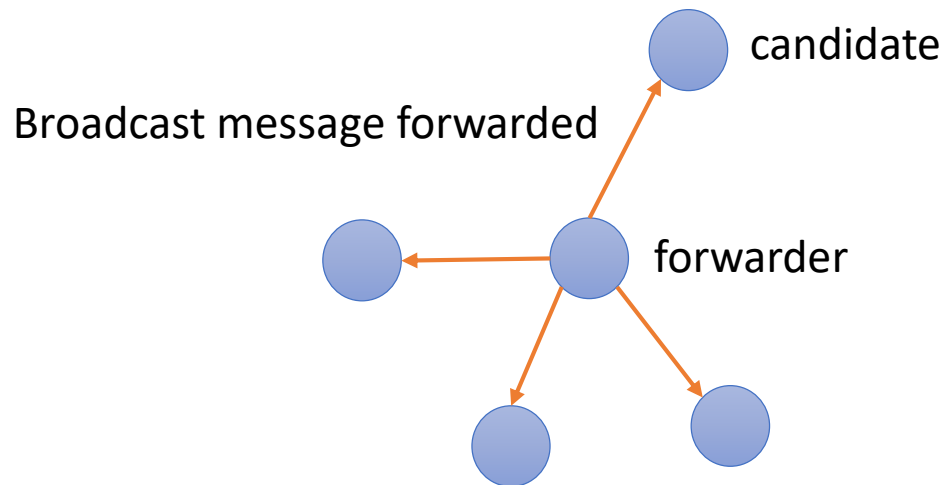 - Out of date NeighborTable

Beaconless Routing

- Beaconless
    - Don't use NeighborTable, each neighbor decides to be nexthop.
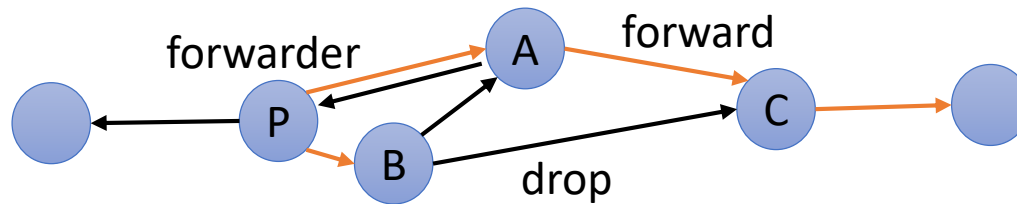   - Delay function

    $$Add\_delay = Max\_delay \frac{r - p}{r}$$

    - "A novel position-based and beacon-less routing algorithm for mobile ad-hoc networks" - 2003

candidate

Broadcast message forwarded

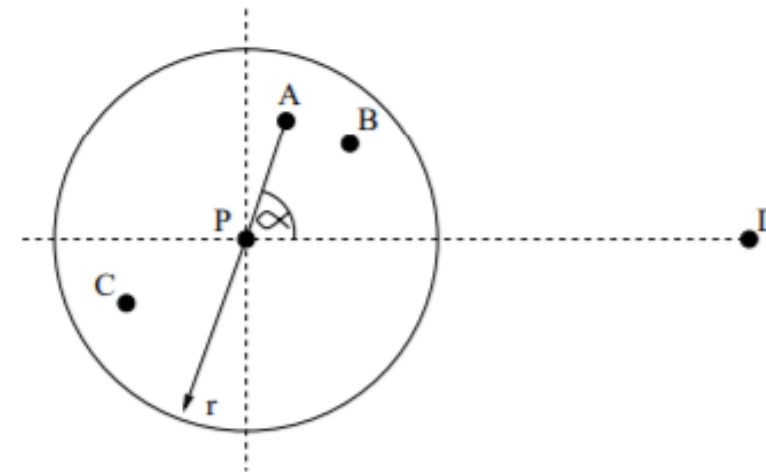forwarder

Beaconless Routing

- Basic mode

- Backup mode / Recovery mode
  - If no further forwarding
  - Request neighbor's position
  - Clockwise-relaying

$$Add\_delay = Max\_delay \frac{\alpha - 90^o}{360^o}$$

Beaconless Routing

- Advantages
  - No Hello message, no NeighborTable
- Disadvantages
  - Duplicate packet
  - Inefficient in Backup mode
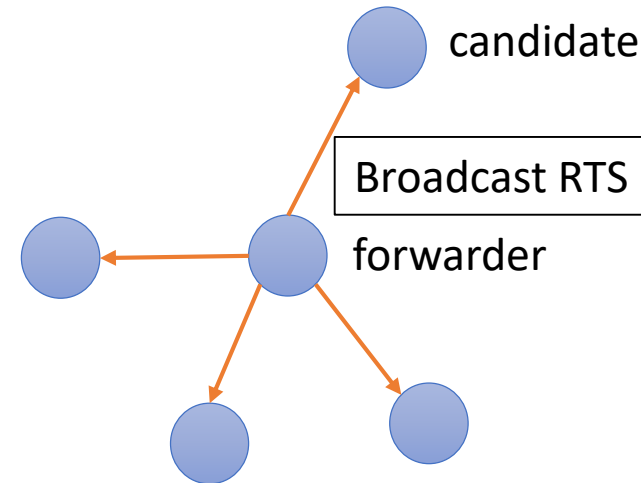
Contention-based

- Improve Beaconless
  - Use RTS/CTS scheme
    - RTS – Request to Send
    - CTS – Clear to Seed
  - Scheme
    - Forwarder broadcast RTS
    - Candidate compute delay function
    - SetTimer to reply CTS
    - If timer expired candidate send CTS
    - If candidate receive CTS from other candidate then discard the timer
    - Forwarder receive CTS, forward DATA to nexthop
  - "MACA - A New Channel Access Method for Packet Radio" – 1990
  - IEEE 802.11

candidate

Broadcast RTS

forwarder

Contention-based

- Delay function
  - "the advance" – to compute delay function
    - Distance to destination
    - Angle of candidate and forwarder with destination
    - … (depend on variant algorithm)
  - Require
    - Current position
    - Destination position
    - Forwarder position
    - … (depend on algorithm)

$$Add\_delay = Max\_delay * \text{"the advance"}$$
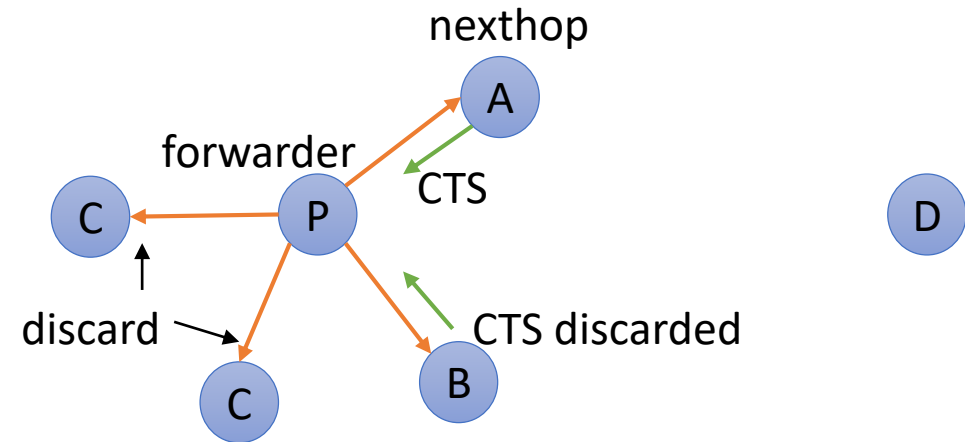
Contention-based

- Position-based
  - Like Greedy

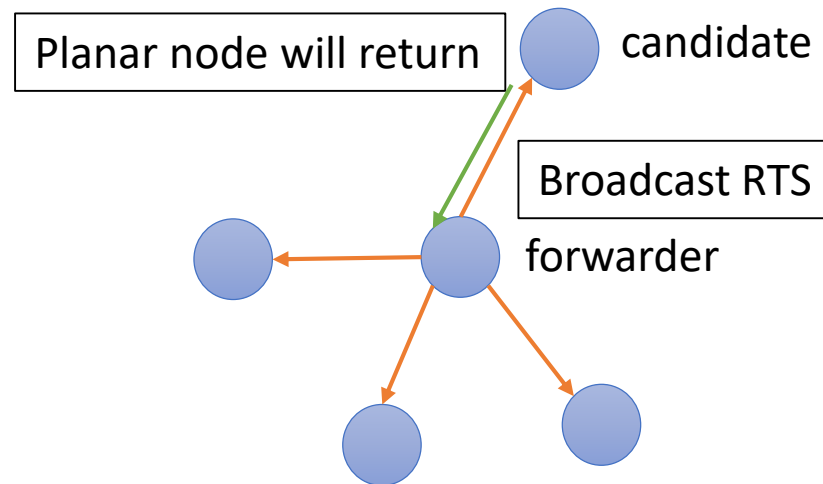$$t_{\text{greedy}}(a) = \left(1 - \frac{a}{r}\right) \cdot t_{\text{max}}$$

$$a \ := \ |vT| - |wT|.$$

- Problem – stuck node
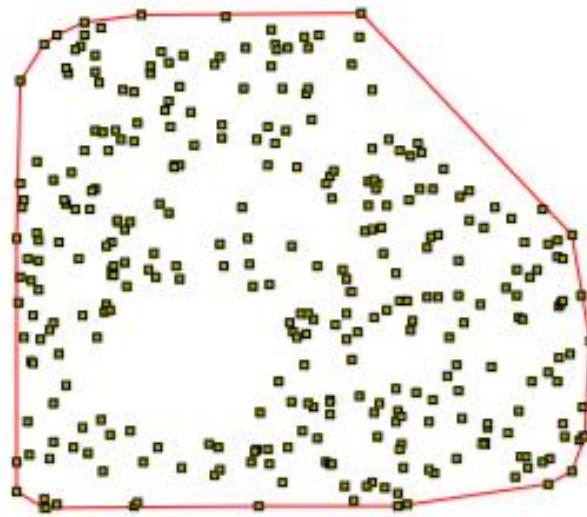 - Recovery mode – face routing

Beaconless Forwarder Planarization

- BFP (2008)
  - Basic mode
    - Contention-based – like greedy
  - Beaconless recovery
    - Use RTS/CTS scheme to construct planar graph
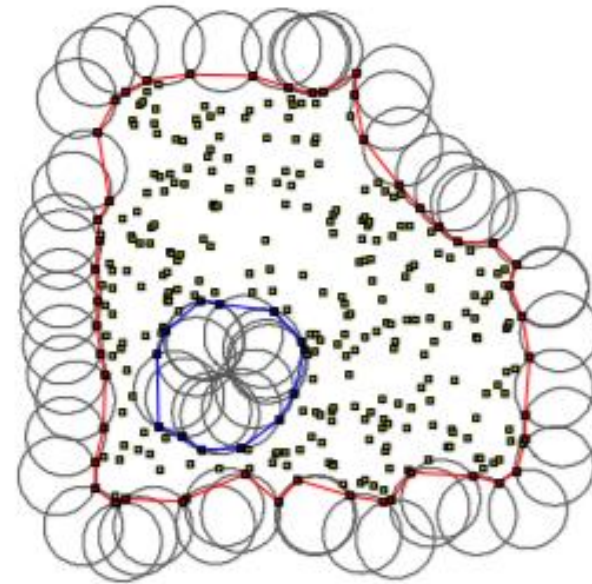   - Locally select next hop

Alpha-shape boundary

- Alpha-shape – planar graph
  - Rolling ball
  - Reuleaux triangle


(a) Convex Hull.

(b) α-shape.

"On the shape of a set of points in the plane" - IEEE Transactions on Information Theory, vol. IT-29(4), pp. 551–559, 1983

Alpha-shape boundary

- "Rolling ball" vs TENT Rule

| Rolling ball	TENT Rule
- Target: Find nexthop by clockwise or counter-clockwise	
- Nexthop is on planar graph - No loop, 1 alpha-shape for each hole	- Nexthop maybe not on planar graph - Maybe loop, maybe existe many boundhole

Rotational Sweep Algorithm

- "Optimizing Communication Overhead while Reducing Path Length in Beaconless Georouting with Guaranteed Delivery for Wireless Sensor Networks" - Stefan Ruehrup and Ivan Stojmenovic - 2012 IEEE

- Rotational Sweep
  - Sweep Circle – like rolling ball
  - Twisting triangle

- Advantages
  - Beaconless totally
  - Compute alpha-boundary on candidate
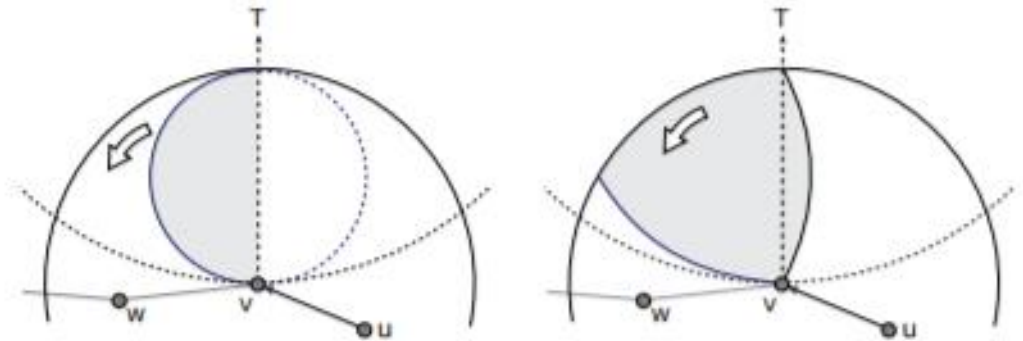
Rotational Sweep Algorithm

- ## Sweep Circle
  - ### Delay function

$$t(d,\theta) = \begin{cases} \dfrac{\theta - \gamma(d) - \delta}{2\pi} t_{\max} & \text{if } \theta - \gamma(d) > \delta \\ \infty & \text{otherwise.} \end{cases}$$
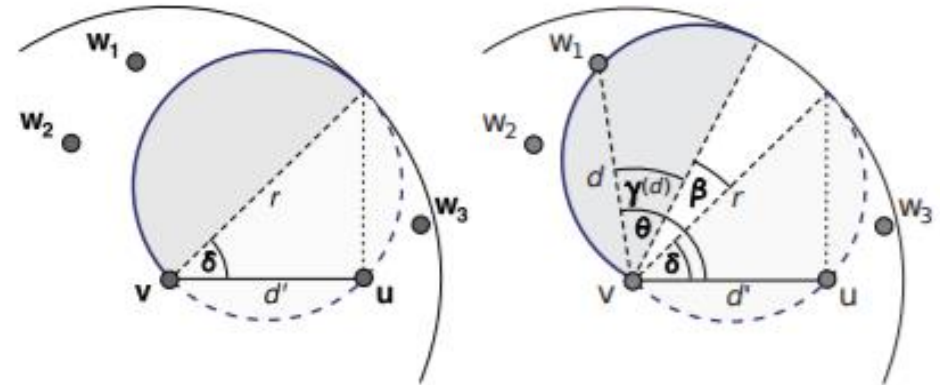
ALBA-R

- Routing
  - Contention-based
- Load balancing
  - Queue priority index (QPI)
  - Geographic priority index (GPI)
  - Rainbow table

THANK YOU