Lecture 15-20: Geographic routing protocols for Vehicular Ad hoc NETworks (VANETs)

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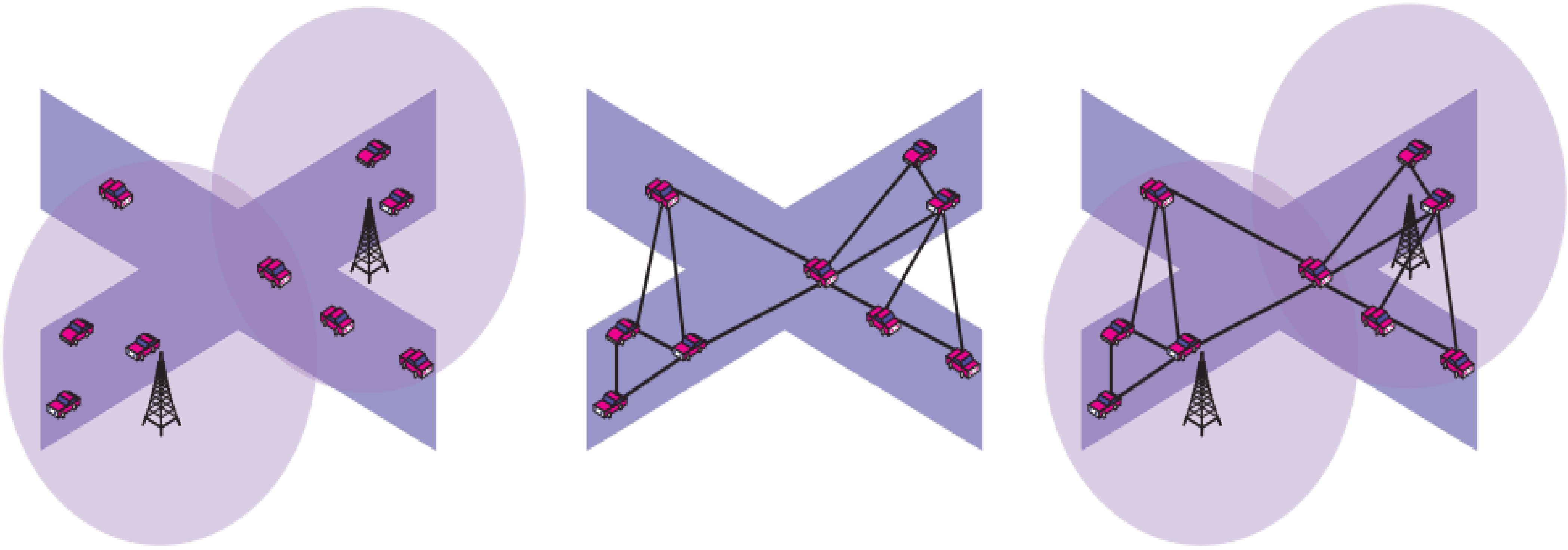
Three possible network architectures for VANETs



(a) WLAN/Cellular (b) Ad Hoc (c) Hybrid

VANET Routing protocols

- Topology-based routing
- Opportunistic Routing,
- Geographic routing

Topology-based routing

- Reactive protocols
  - Determine route if and when needed
  - Source initiates route discovery
  - Example:
  - DSR (Dynamic Source Routing)
  - AODV (Ad hoc On-Demand Distance Vector)
- Proactive protocols
  - Traditional distributed shortest-path protocols
  - Maintain routes between every host pair at all times
  - Based on periodic updates; High routing overhead
  - Example: DSDV (destination sequenced distance vector)
  - Optimized Link State Routing (OLSR)
- Hybrid protocols
  - Adaptive; Combination of proactive and reactive
  - Example : ZRP (zone routing protocol)

Opportunistic Routing,

1. **Performance metric calculation**
2. **Candidate node selection and prioritization**
3. **Candidate coordination**

Geographic routing

- Node movement in VANETs is usually restricted in just **bidirectional movements constrained along roads and streets.**
- So routing strategies that use geographical location information obtained from street maps, traffic models or even more prevalent navigational systems on-board the vehicles make sense.
- This fact receives support from a number of studies that **compare the performance of topology-based routing (such as AODV and DSR) against position-based routing strategies in urban as well highway traffic scenarios** .
- Therefore, **geographic routing (position-based routing)** has been identified as a more promising routing paradigm for VANETs

Geographic routing

- **Geographic routing** (also called **georouting**[1] or **position-based routing**) is a routing principle that relies on geographic position information.
- It is mainly proposed for wireless networks and based on the idea that the source sends a message to the geographic location of the destination instead of using the network address.
- In the area of packet radio networks, the idea of using position information for routing was first proposed in the 1980s[2] for interconnection networks.[3]
- Geographic routing requires that each node can determine its own location and that the source is aware of the location of the destination.
- With this information, a message can be routed to the destination without knowledge of the network topology or a prior route discovery.

Geographic routing

- Even though vehicular nodes in a network can make use of **position information in routing decisions**, such algorithms still have some challenges to overcome.
- Most position based routing algorithms base **forwarding decisions on location information.**
- For example, **greedy routing** always forwards the packet to the node that is geographically closest to the destination.

Challenges in the design of position-based routing protocols for Vehicular Ad hoc NETworks

- High dynamic topology:
- Frequent network disconnection:
- Mobility modeling and prediction:
- Propagation model:
- Communication environment
- Delay constraints:
- Quality of Service (QoS)

Geographic routing Categories

- Position-Based Routing can be divided into three categories:

1. Non-Delay Tolerant Vehicular Ad hoc NETworks (Non-DTVANETs),
2. Delay Tolerant Vehicular Ad hoc NETworks (DTVANETs), and
3. Hybrid.

Non-DTVANETs , DTVANETs and Hybrid

- The NonDTVANETs protocols do not consider intermittent connectivity and are only practical in densely populated VANETs while the DTVANETs protocols do not consider disconnectivity and are designed from the perspective that networks are disconnected by default. Hybrid types combine the Non-DTVANETs and the DTVANETs to exploit partial network connectivity

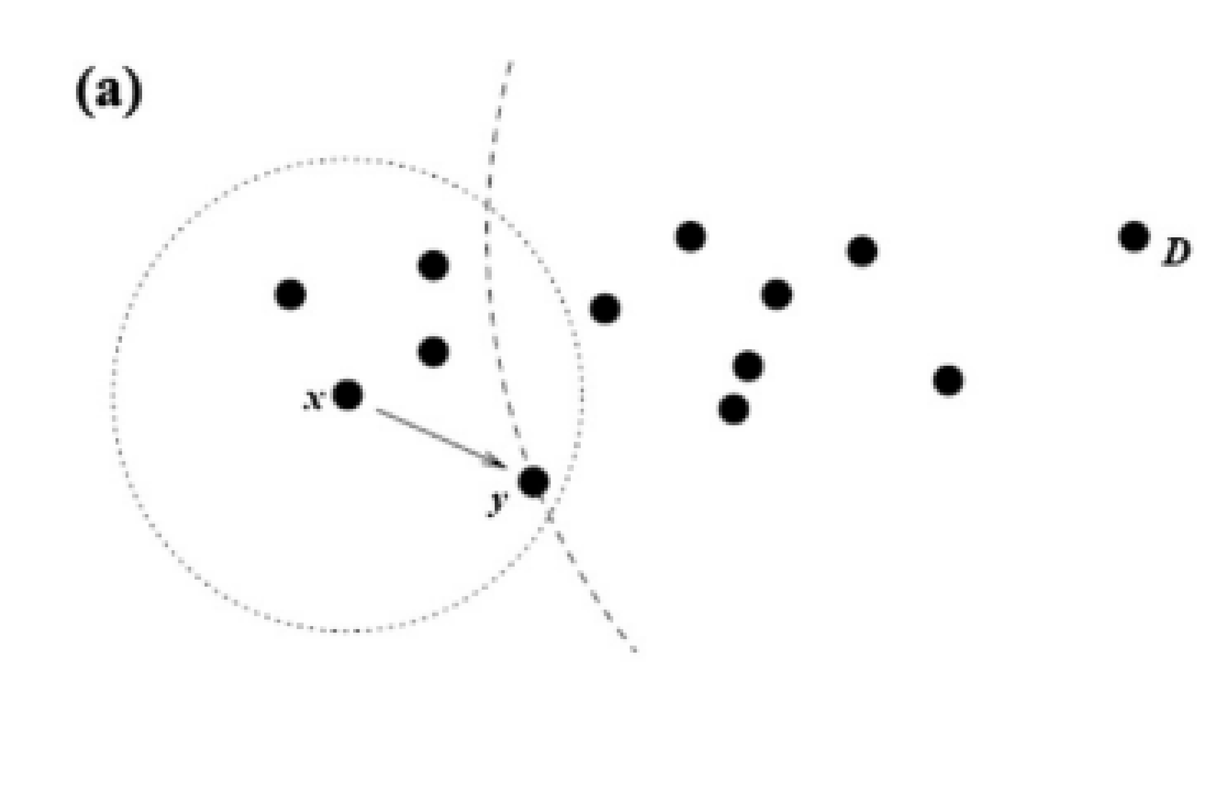
GPSR (*Greedy Perimeter Stateless Routing*)

- GPSR describes a position-based routing protocol called *Greedy Perimeter Stateless Routing* which became one of the most cited work.
- It consists of a standard *greedy forwarding* mode and a *recovery method* called *perimeter forwarding* used in the cases where a local optimum occurs.

Example

- A simple example of greedy forwarding appears in Fig. 1a.
- **Here, x wants to send a packet to *D*** or receives a packet destined for *D*.
- x forwards the packet to *y*, as the distance between *y* and *D* is less than that between *D* and any of x's other neighbors.
- This greedy forwarding process is repeated until the packet reaches *D*.

Greedy forwarding



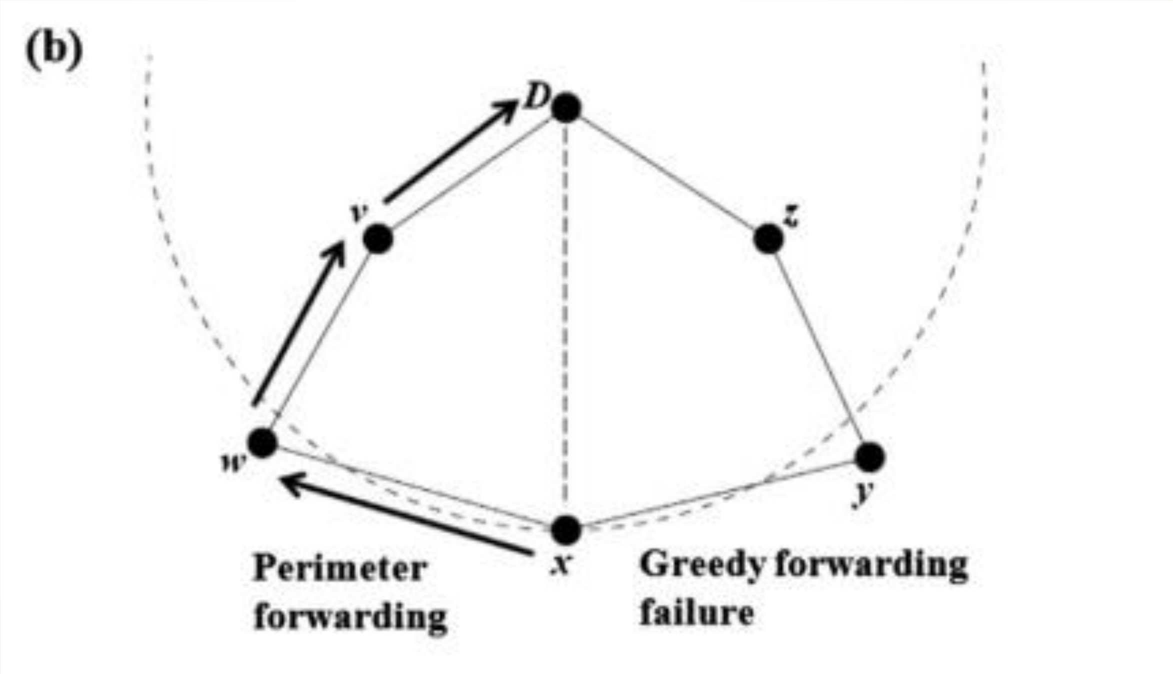
Example for Perimeter mode

- When a local optimum occurs, the perimeter forwarding of GPSR uses the long-known *right-hand rule* for crossing a graph.
- As shown in Fig. 1 (b), x is closer to D than its neighbors w and y.
- The dotted arc on D has a radius equal to the distance between x and D.
- If two paths, $(x \rightarrow y \rightarrow z \rightarrow D)$ and $(x \rightarrow w \rightarrow v \rightarrow D)$, exist at D, then x will not choose to transmit to w or y using the greedy approach.
- x is a local optimum in its proximity to D.

Example for Perimeter mode

- Hence, the right hand rule tries to bypasses this local optimum by browsing a virtual arc (that connects the node of the local optimum to the destination node) in the opposite direction of a clock hand to search a node that is the closest to the destination D than the node of the local optimum.
- In this case, the node w will be the candidate and the packet will be transmitted on the path ($x \rightarrow w \rightarrow v \rightarrow D$).

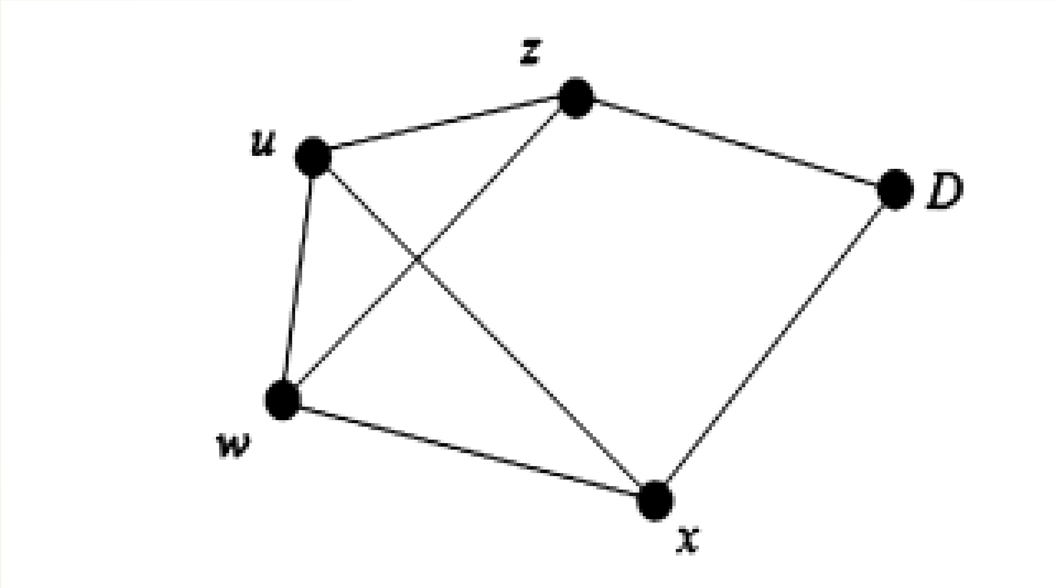
Perimeter mode



Non-planar graph

- For obvious reasons, the right-hand rule requires that all the edges are not crossing (the graph must be planar).
- Taking the example of the Fig. 3. x originates the packet to u.
- The application of the right hand rule results in the tour: $(x \rightarrow u \rightarrow z \rightarrow w \rightarrow u \rightarrow x)$.
- So, on graphs with edges that cross (non-planar graphs), right-hand rule may not tour enclosed face boundary.
- However, by deleting the edge (w, z), the path will be: $(x \rightarrow u \rightarrow z \rightarrow D)$.

An example of a non-planar graph



GPSR

- Since GPSR works on an unobstructed plane, the authors propose an approach to obtain a planar graph without crossing the
  network.
- However, this leads to an overhead of the network.

Geographic routing

- GPSR (*Greedy Perimeter Stateless Routing*)
- *Geographic Source Routing* (GSR)
- GPCR (*Greedy Perimeter Coordinator Routing*)
- A-STAR (Anchor-*based Street and Traffic Aware Routing*)


THANK
YOU