Signaling and QoS guarantees in mobile ad hoc networks

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Po Yu Chen

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Goal

- To purpose an architecture for provisioning nondisrupted QoS guarantees in mobile ad hoc networks, and extend the scalable resource reservation protocol (SRRP) for signaling in ad hoc networks.

Outline

- Introduction
- Enabling QoS guarantees in MANETs
- Signaling and QoS adaptation in MANETs
- Nondisrupted QoS guarantees in MANETs
- Conclusion

Introduction

Introduction

- Signaling and QoS guarantees are important for voice and multimedia applications in such networks
- In ad hoc networks, routers are mobile and the network topology is dynamic, introducing a problem to be referred to as the *moving terminal problem*

Introduction (cont'd)

- Moving terminal problem
  - Data packets may collide at receivers after their RTS/CTS dialogues or
  - Carrier sensing and the reservations made at mobile routers may conflict with each other at a later time due to movements of the routers

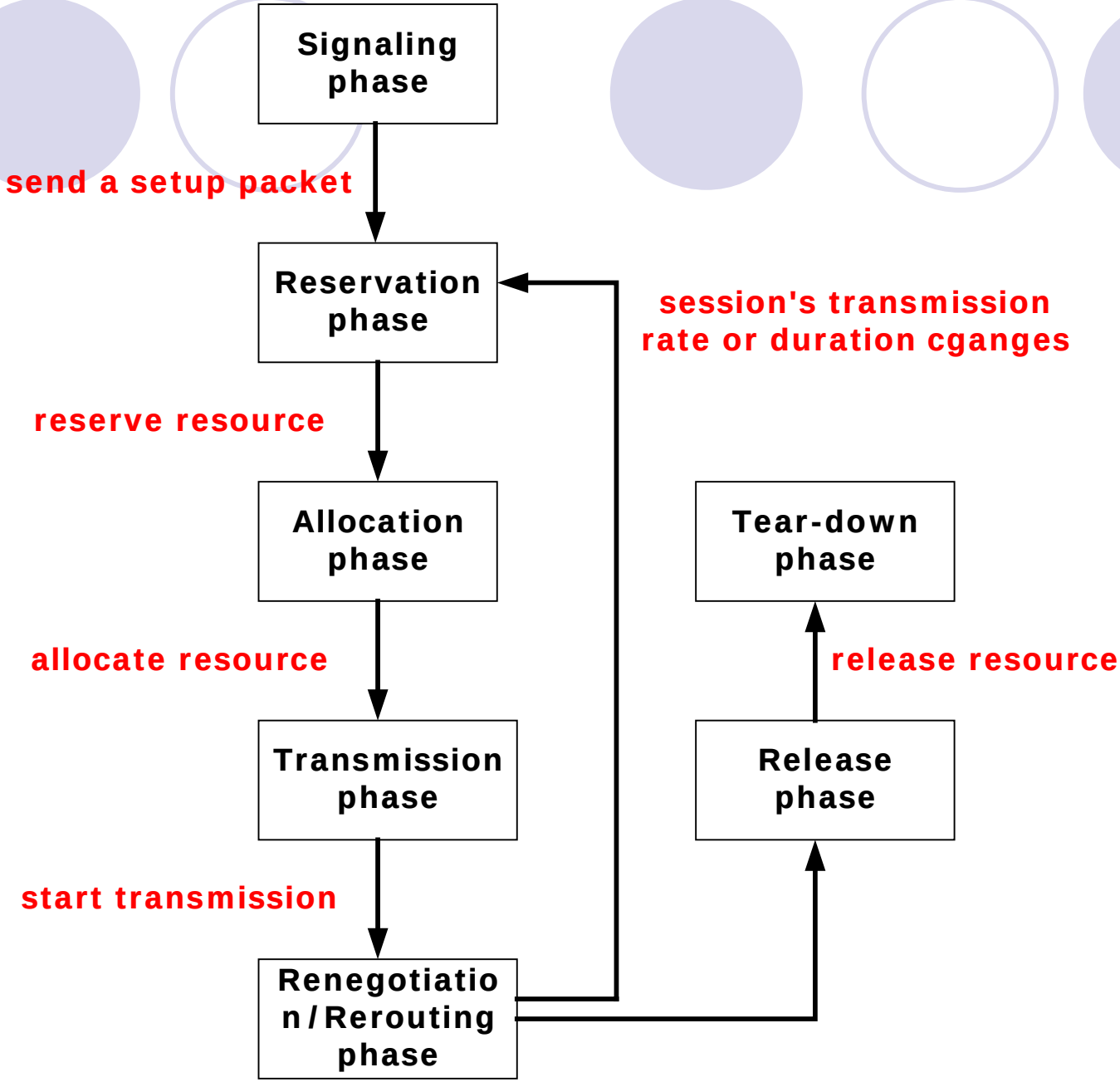
Enabling QoS guarantees in MANETs

SRRP (Scalable Resource Reservation Protocol)

- To develop a scalable, adaptive, reliable, efficient, and universal signaling protocol
- A problem with previous signaling protocols
  - Round-trip time or one way propagation delay
- The timed reservation concept
  - Scalability problem
- The slotted reservation
  - Achieve better scalability

SRRP (Scalable Resource Reservation Protocol) (cont'd)

- The author developed SRRP with seven pipeline phases
  - 1. Setup phase
  - 2. Reservation phase
  - 3. Allocation phase
  - 4. Transmission phase
  - 5. Renegotiation/Rerouting phase
  - 6. Release phase
  - 7. Tear-down phase


Signaling phase
send a setup packet
Reservation phase
session's transmission rate or duration cganges
reserve resource
Allocation phase
Tear-down phase
allocate resource
release resource
Transmission phase
Release phase
start transmission
Renegotiation/Rerouting phase

Enabling QoS guarantees in MANETs

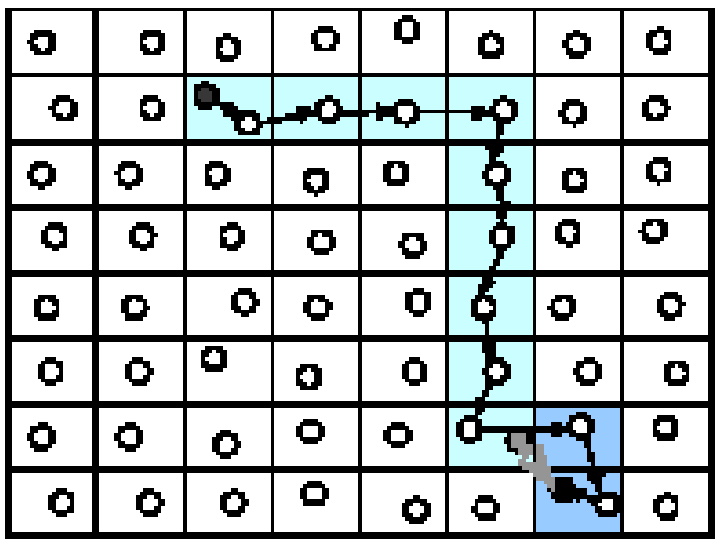
- **GRACE**: A Geographical Reservation Scheme for MANETs
- **ROC**: A Distributed Reservation Mechanism for MANETs
- **Ad-hoc MPLS** for Virtual-connection-oriented MANETs
- These mechanism and schemes are specialized for ad-hoc SRRP

GRACE (Geographical Reservation and Clusterhead Election)

- In several previous protocols, reservations are made in a **node-by-node** manner
- GRACE reserves resource in a **region-by-region** manner
  - The physical space is partitioned into cells
  - A clusterhead is elected from each cells
  - A clusterhead serves as the resource broker for its cell

GRACE (Geographical Reservation and Clusterhead Election) (cont'd)

- Geographically fixed route
  - The set of cells do not change with time
  - The route remains almost the same geographically during the life time of QoS session



ROC (**R**equest-to-reserve/**O**bject-to-reserve/**C**lear-to-reserve)

- The ROC reservation mechanism for intermediate routers to reserve resources in a distributed manner
- Steps to establish a QoS session
  - The SRRP setup packet carriers with the information of the resource reservation
  - The clusterhead with the setup packet sends a RTR packet to the downstream clusterhead and also multicast the packet to other clusterhead within the **interference** range

ROC (**R**equest-to-reserve/**O**bject-to-reserve/**C**lear-to-reserve) (cont'd)

- The purpose of the RTR message
  - To inquire the downstream node whether the interference and the traffic load are low enough to receive the scheduled packets
  - To inquire other heads within the interference range weather the intended transmission may collide with the transmission scheduled in their cells

ROC (**R**equest-to-reserve/**O**bject-to-reserve/**C**lear-to-reserve) (cont'd)

- OTR message
  - If the interference range is not entirely covered by the range of the requesting head, we need to use a relayed geocasting mechanism to forward the RTR to all the heads within the interference range
  - If a head receives the RTR message during overlapped periods of time, it informs the requesting head with an OTR message

ROC (**R**equest-to-reserve/**O**bject-to-reserve/**C**lear-to-reserve) (cont'd)

- The requesting head has to request different schedule or to reject the setup request

- CTR
  - If the requesting head receives a CTR message from downstream head and does not receive any OTR message after waiting for a period of time
  - Then it has successfully received the required resource and can admit the QoS session

ROC (**R**equest-to-reserve/**O**bject-to-reserve/**C**lear-to-reserve) (cont'd)

- The advantages of the ROC
  - Simple
  - Setup packet is processed at multiple clusterheads in parallel

Ad-hoc MPLS

- In order to provide QoS guarantees, packet from QoS session should be routed in a connection oriented or similar manner as in MPLS or ATM networks
- Difference
  - The intermediate nodes for QoS session may change in mobile ad hoc networks in order to guarantee QoS

Ad-hoc MPLS (cont'd)

- Base on GRACE
  - Each cell is assigned a virtual IP address
  - The virtual IP address of a cell is then dynamically pointing to the MN that is currently serving as its clusterhead
- A packet is then switched from cell to cell as specified in the virtual LSP
- In general, we can partition a cell into smaller regions

Signaling and QoS adaptation in MANETs

- Penalty-based adaptable reservation
- PARIS: Priority-based Aggressive reservation Interactive Scheme
- Shared Virtual Reservation for Protection and Restoration
- Alternative Reservation with Traffic/Demand Engineering

Penalty-based adaptable reservation

- Two reservation mode
  - Normal mode
    - There is sufficient resource
  - Degrade mode
    - There is no sufficient resource
    - A mobile host holds a certain amount of traffic that is time-noncritical
    - If this is still insufficient, the MH reallocates the required bandwidth under degradation to some connections that have lower priority and smaller penalty

Penalty-based adaptable reservation (cont'd)

- Types of adaptable applications
  - **Survivable** applications
    - The intermediate router can drop its packets with lower priority when necessary without having to inform the application
  - **Negotiable** applications
    - The intermediate router should not drop its packets but can inform the application to reduce its transmission rate
  - **Hybrid** survivable/negotiable applications
    - The intermediate router can drop its packet to reduce its bandwidth to a certain degree

PARIS

- To reserve resources for the **worst-case** is a waste of resources
- It classifies requests into **p** classes
  - Every class has three thresholds
    - Cell, Link, Class
  - High priority class can reduce low priority class's bandwidth (guarantee high priority)
  - Using **average-case** to instead of worst-case to increase the throughput

Shared Virtual Reservation for Protection and Restoration

- The virtual reservations of the protection are utilizing the adaptable part of the cell bandwidth
- Different MHs are allowed to share a *common virtual reservation* for their protection

Alternative Reservation with Traffic/ Demand Engineering

- An appropriate amount of resources are reserved for each of the modes
- For example
  - Mode 1
    - A worst-case reservation along the shortest path
  - Mode 2
    - A worst-case reservation along the longer path
  - Mode 3
    - A average-case reservation along the shortest path

Alternative Reservation with Traffic/ Demand Engineering (cont'd)

- When the traffic is light,
  - The network operates at mode 1
- If the traffic load is increased above a certain threshold,
  - The operation switches to mode 2
- When the traffic is heavy
  - The operation may switch to mode 3

Alternative Reservation with Traffic/ Demand Engineering (cont'd)

- Disadvantage
  - There is overhead associated with switching between difference modes
- The network switches back to a lower-numbered mode
  - When the network remains at a lower traffic load for a sufficiently long period of time

Signaling and QoS guarantees in mobile ad hoc networks

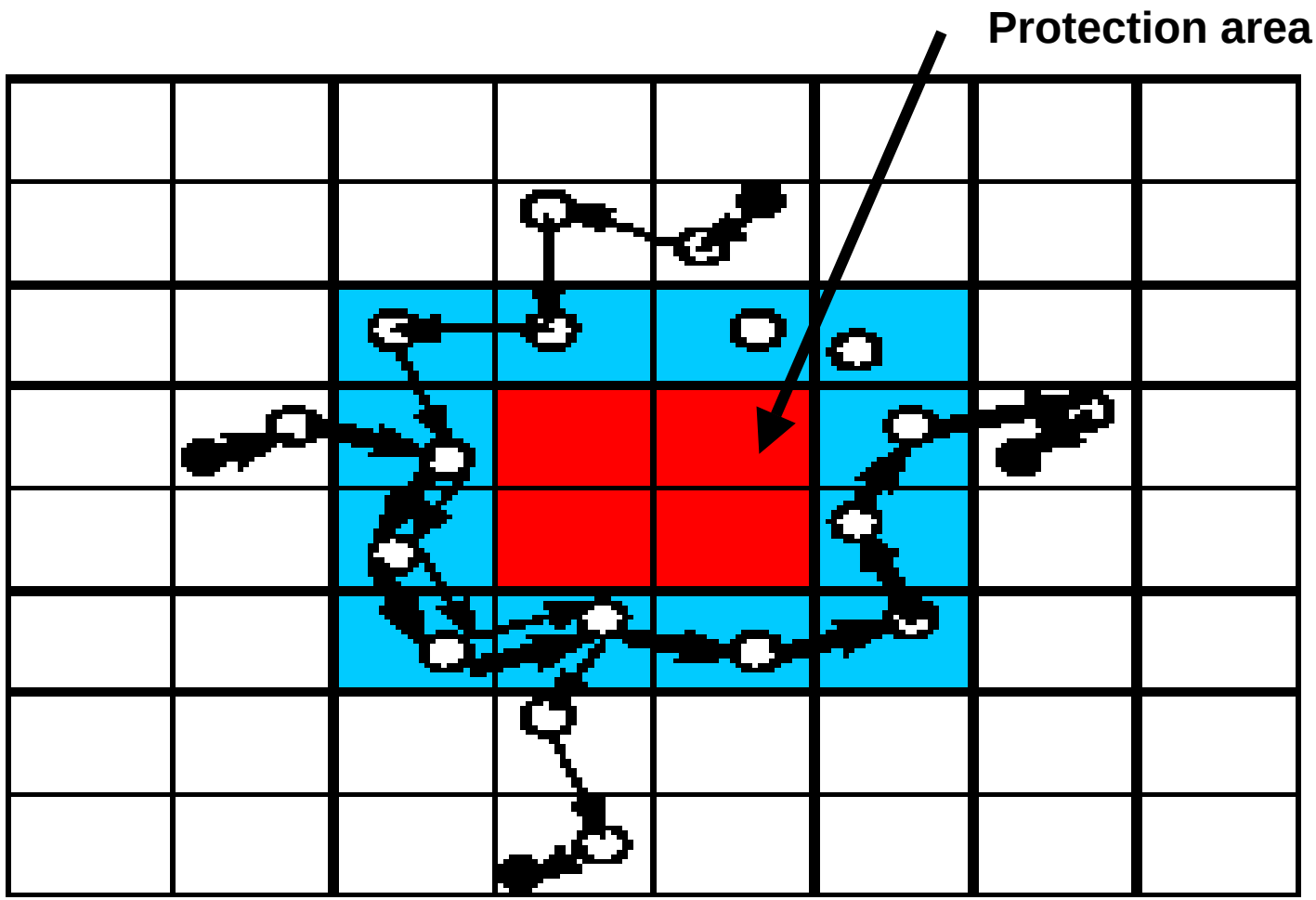
Nondisrupted QoS guarantees in MANETs

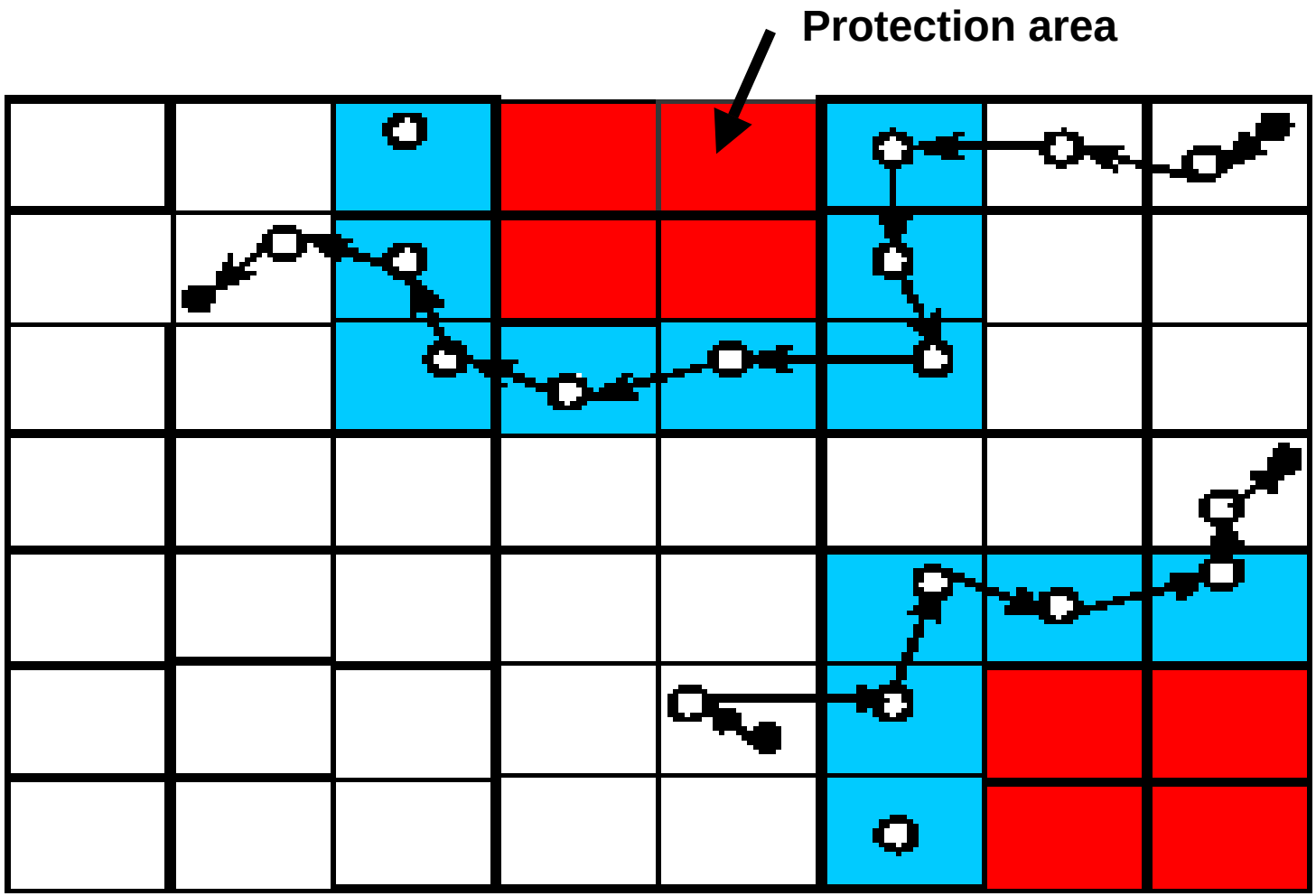
Nondisrupted QoS guarantees in MANETs

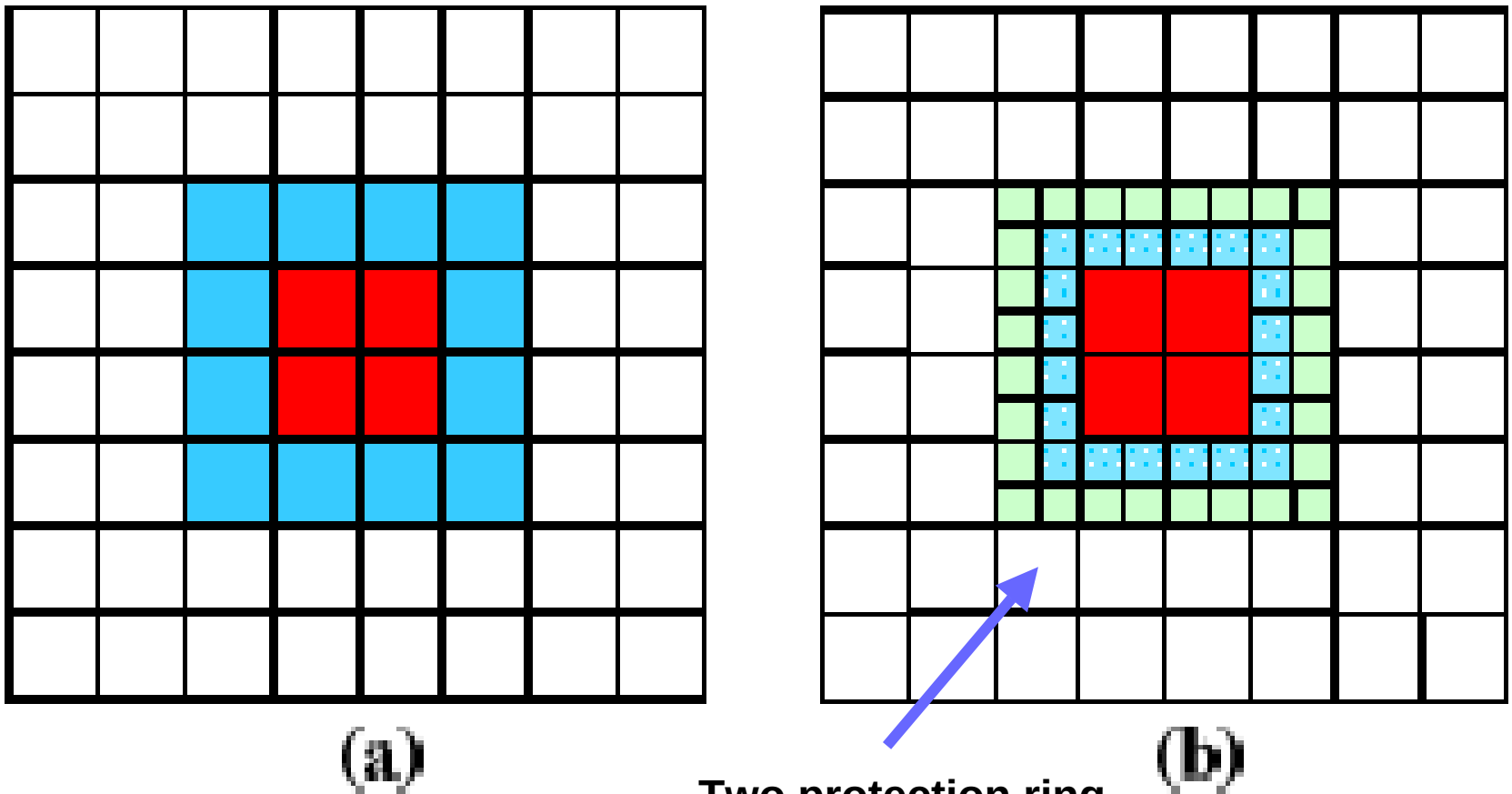
- Techniques for fault protection are based on
  - Link protection
  - Node protection
  - Path protection
  - Subpath protection
- The author purpose *geographical protection techniques*
  - *Several protection subpaths with shared virtual reservation are established*

Nondisrupted QoS guarantees in MANETs

- We can protect a geographical area
  - Geographical Area Protection (GAP)
- Geographical circumscribed protection
  - Which establishes one or several protection rings surrounding the protection area
- Advantages of comparing to cell protection
  - Smaller overhead
  - Processing requirement for signaling
  - Total resources reserved


Protection area


Protection area


(a)
(b)
Two protection ring

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Conclusion

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- The author purposes several reservation mechanism for enabling QoS guarantees based on ad hoc SRRP
- GRACE and geographical protection techniques enable QoS guarantees in high mobility ad hoc networks