Optimizing ODMRP for Underwater Networks

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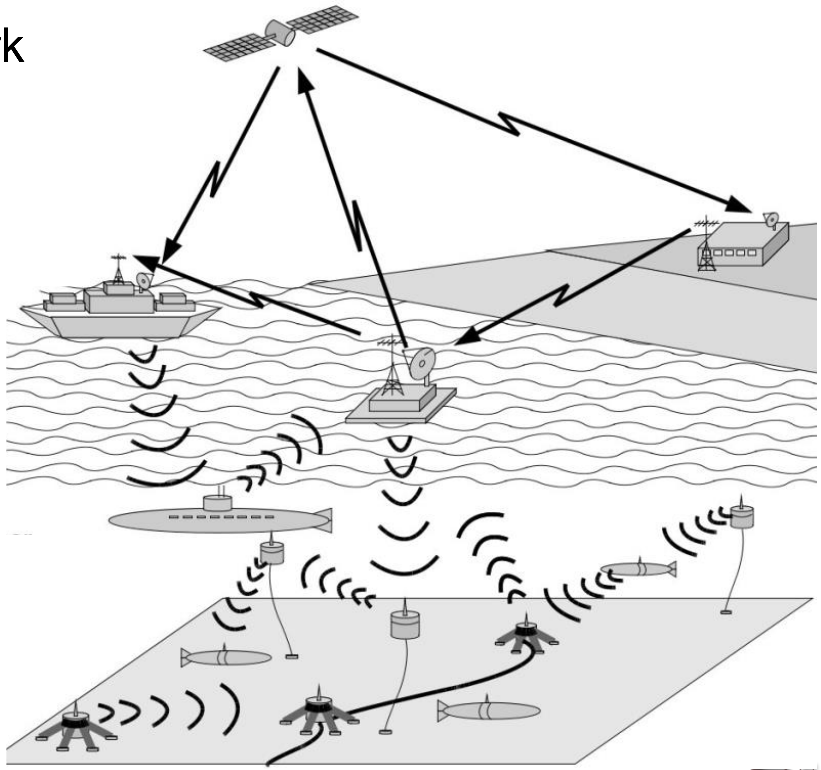
Introduction

Underwater Communication

- rely on acoustic communication

Underwater Acoustic Networks (UAN): many novel applications

- environment /equipment monitoring, exploration, disaster prevention...
- military operations
  - integration of naval units into a network
  - Anti Submarine Warfare (ASW)
  - mine countermeasures
  - surveillance, reconnaissance…



Advantages of UANs

- **faster availability of data**
- **ad-hoc & multi-hop capability**
- **mobile devices**

Outline

- Routing in Underwater Networks
- ODMRP with Route Discovery Suppression (RDS)
- Evaluation
- Conclusion

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Routing in Underwater Networks

Routing in UANs

- **Challenges**
  - low data rates
  - slow signal propagation
  - high bit error rates

- **Our Approach: Adaptation of the terrestrial**

On-Demand Multicast Routing Protocol (ODMRP) [1]

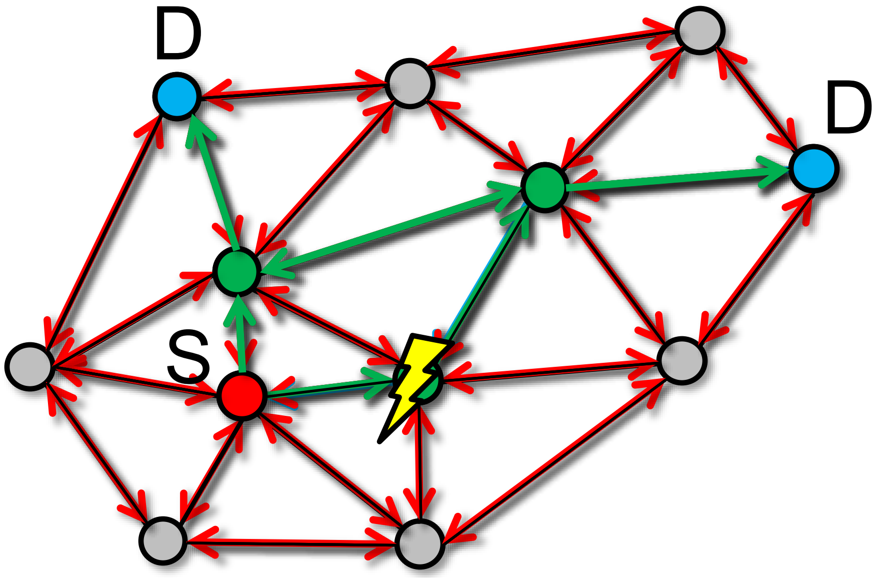
- enables multicast communication
- works with sparse network topologies
- does not require localization

[1] Y. Yi, S.-J. Lee, W. Su, M. Gerla "On-Demand Multicast Routing Protocol (ODMRP) for Ad Hoc Networks", Internet-Draft, IETF MANET Working Group Std., 2002

ODMRP

- reactive
- developed for terrestrial (wifi) networks
- uni- & multicast capability
- scalable
- robust

- **Route Discovery**
  - flooding of **JoinQuery** (backward learning, piggybacking)
  - **JoinReply** unicasts
  - forming a mesh structure
    - sending of **data**
    - → scoped flooding



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ODMRP in UANs

Challenge

- during Route Discovery: **data** is disseminated by **flooding**
- in UAC: very high RTT between source & destination
  - → parallel discoveries

→ **high packet loss probability of JoinReplies**

Solution: Route Discovery Suppression

- **Limitation of the max. number of parallel discoveries**
- **Goal: reduction of discovery delay and routing overhead**

Questions

- **number of discovery attempts?**
- **processing of data during route discovery? Discarding vs. buffering?**

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Evaluation architecture

Simulation

- **ns-2** [2] **with UnderWaterMiracle** [3]
- **Metrics**
  - **overhead factor:**

$$overhead\ factor := \frac{\sum transmitted\ data}{\sum recv.\ user\ data \cdot \#receivers}$$

  - **packet delivery ratio (PDR):**

$$PDR := \frac{\#received\ packets}{\#sent\ packets \cdot \#receivers}$$

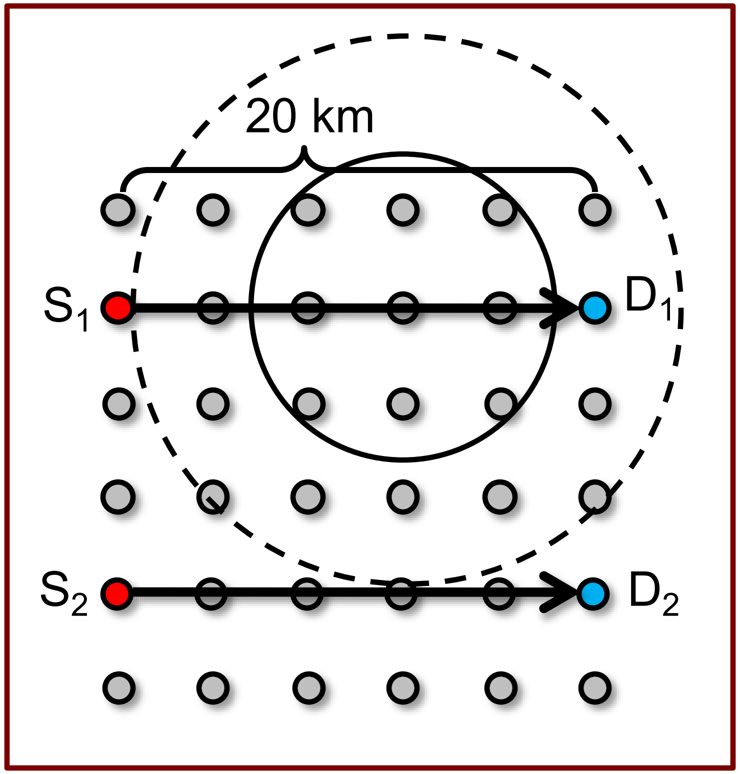
  - **route discovery delay**

- **Protocols** ALOHA, (lightweight) IP, UDP
- **Traffic** periodic (constant bit rate)
- **Assumption** negligible bit errors

[2] Information Sciences Institute, University of Southern California, "The Network Simulator – ns-2", http://www.isi.edu/nsnam/ns/
[3] d.gt Telecommunications Group, Departure of Information Engineering, University of Padova, "Network Simulation", http://telecom.dei.unipd.it/pages/read/58/

Evaluation – scenario

Scenario

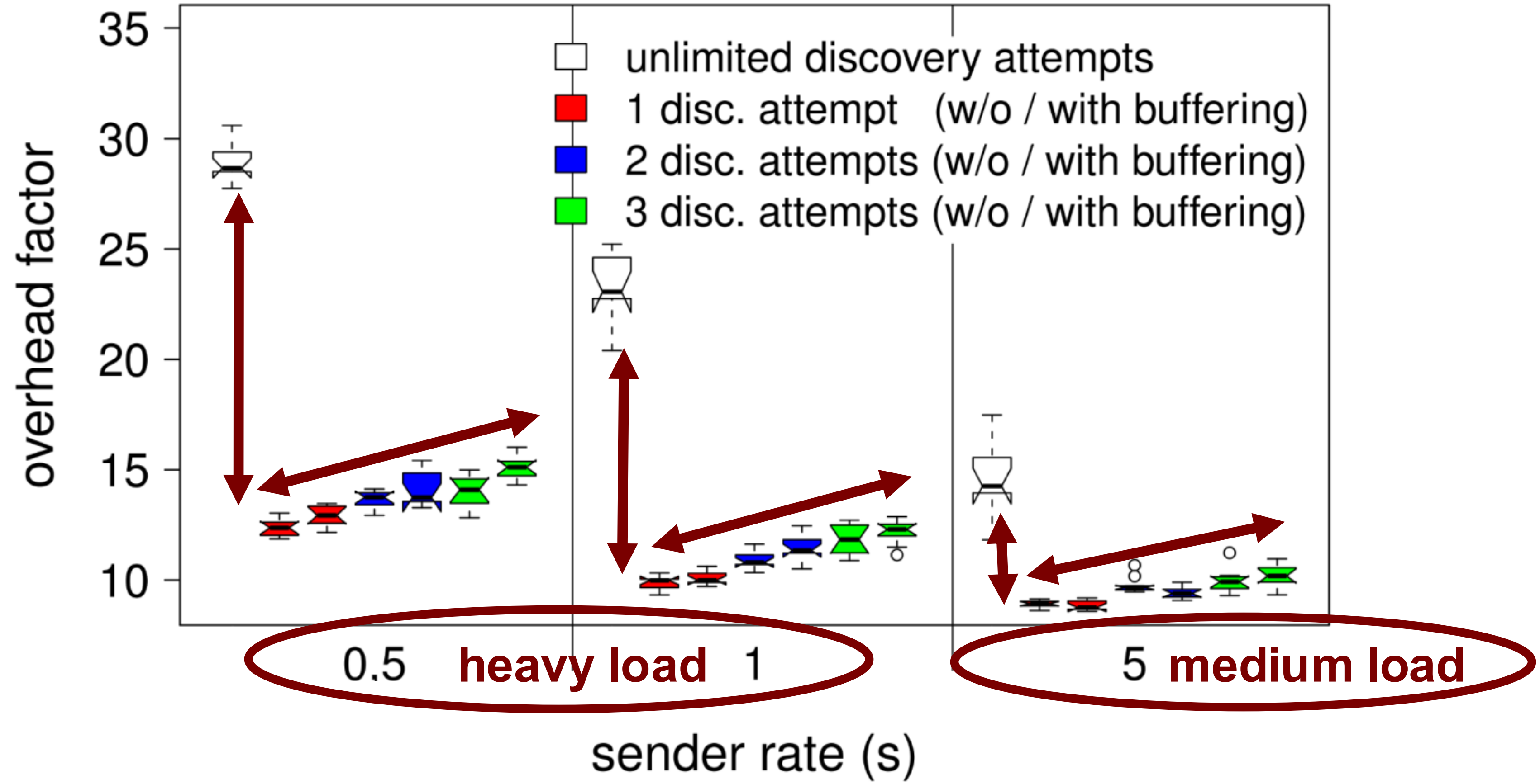


- 6x6 grid topology
- 2 traffic flows
- 5km transmission range

- **ODMRP-RDS**
  - **w/o and with buffering**
  - **discovery attempts: ∞, 1, 2, 3**
  - **discovery timer: 60s**

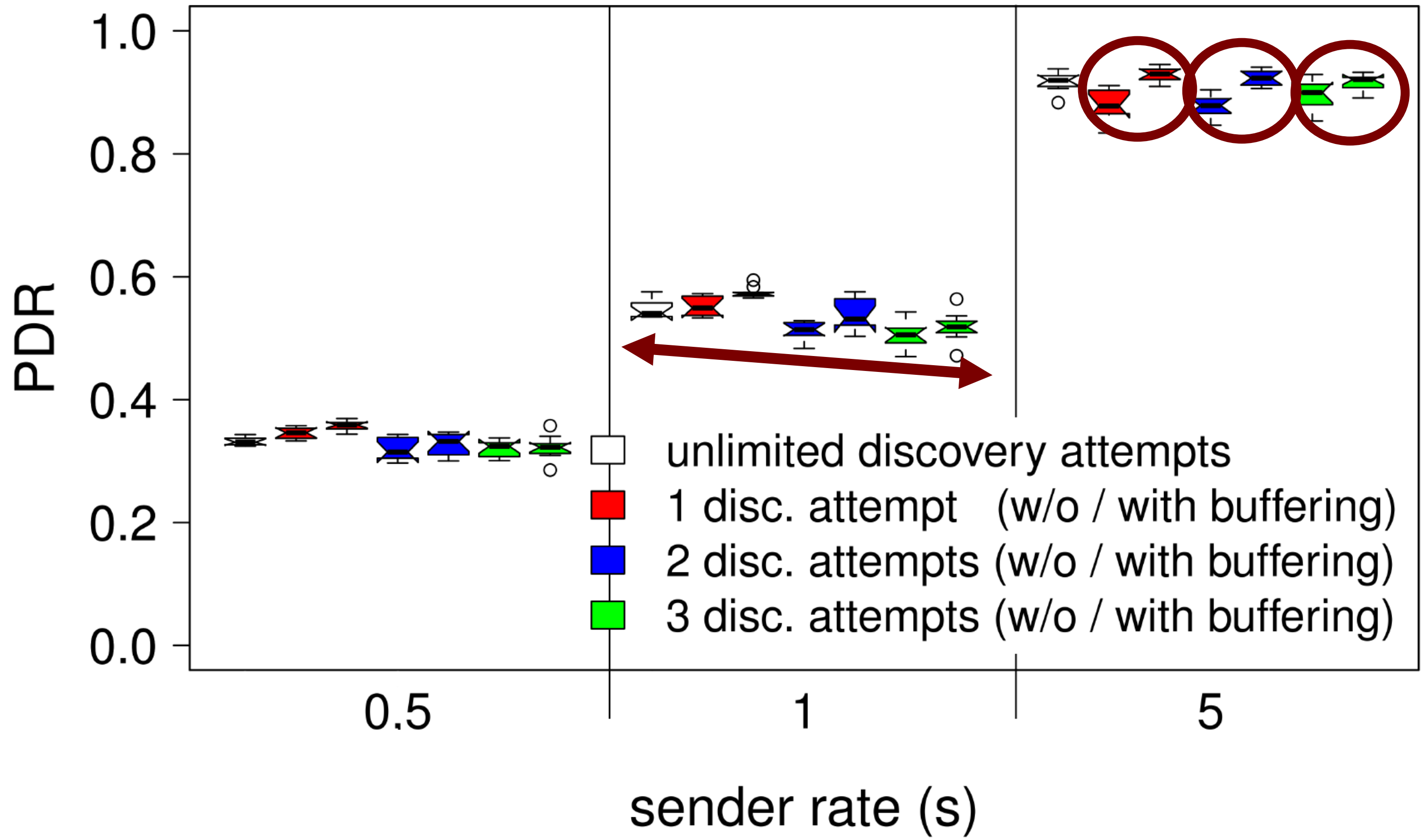
  - route_refresh_interval: 200s
  - fg_timeout_interval: 300s

Evaluation – overhead



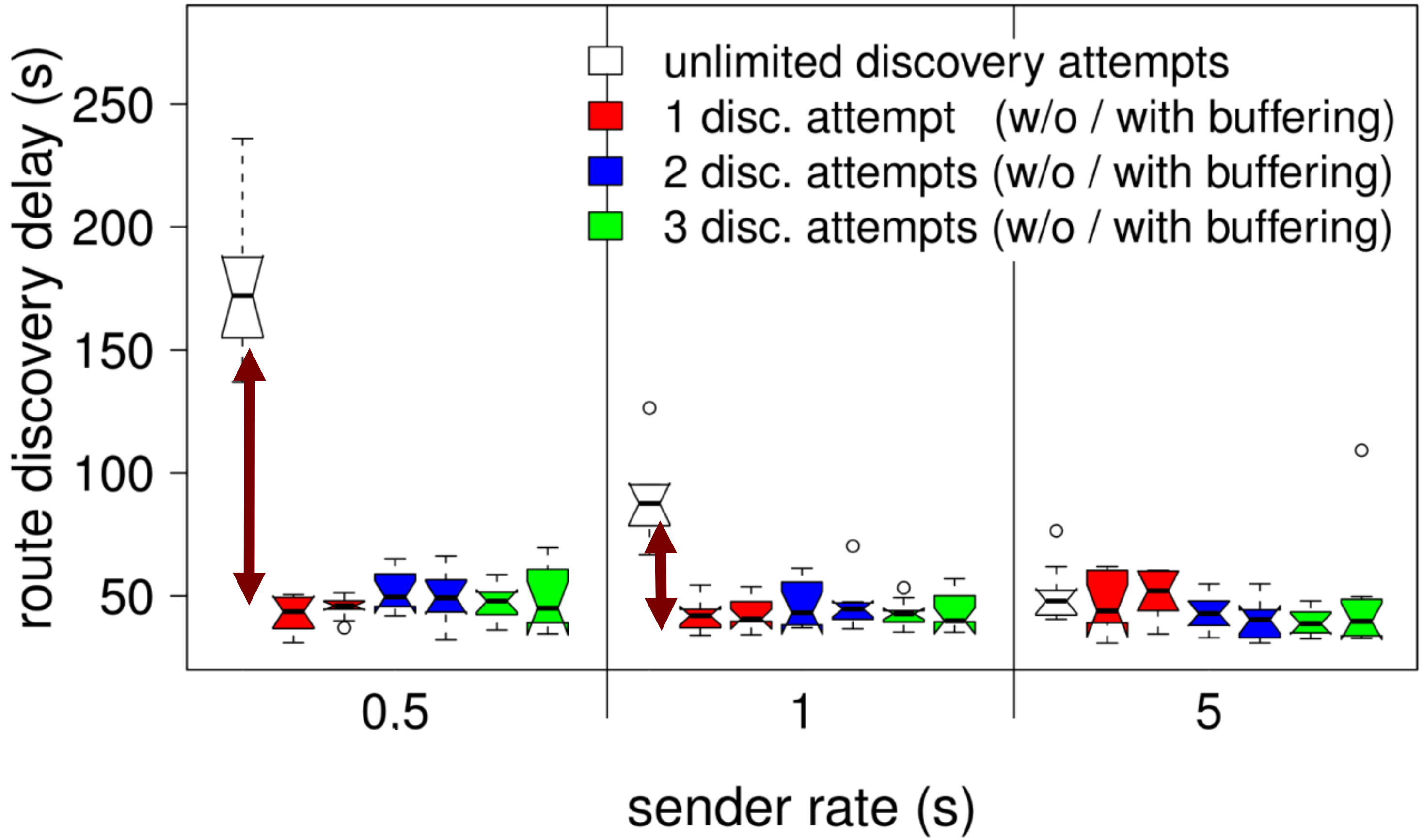
- **RDS**
  - **significant overhead reduction**
  - **one discovery attempt is sufficient**

Evaluation – reliability



- **RDS**
  - **only slight decline of reliability**
- **Buffering**
  - **not advantageous in busy networks**

Evaluation – discovery delay



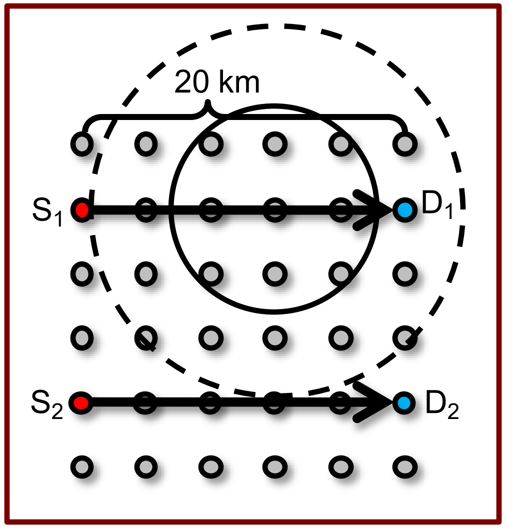
- **RDS**
  - **mitigates route discovery delay in busy networks**

Comparison

Comparison

- simple Flooding
- basic ODMRP
- ORMRP-RDS
- Simplified Multicast Forwarding (SMF) [4]

same scenario

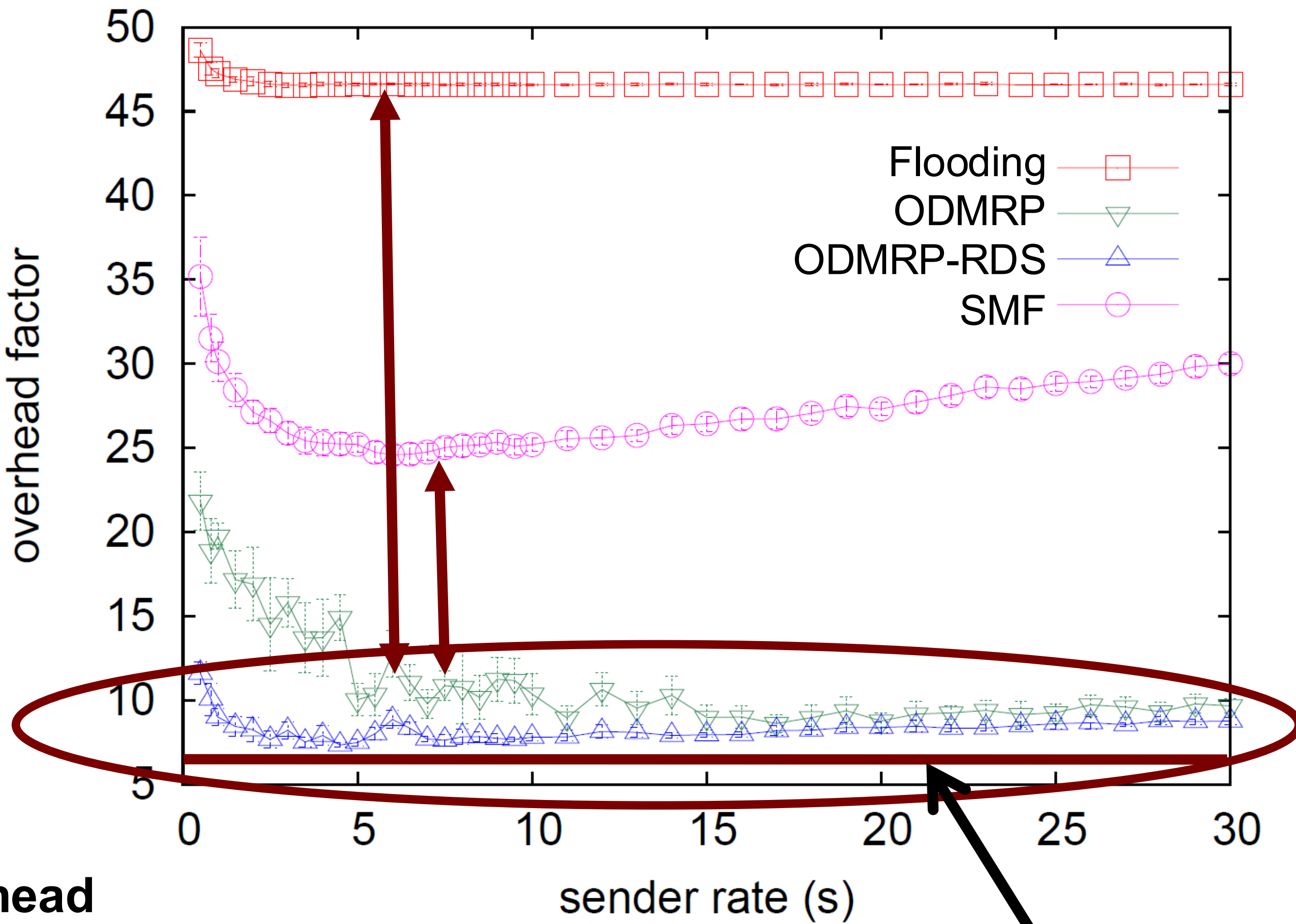


ODMRP-RDS

- w/o buffering
- 1 discovery attempt

[4] J. Macker "Simplified Multicast Forwarding for MANET", Internet-Draft, IETF Network Working Group Std., 2010

Comparison – overhead



- **ODMRP**
  - **lowest overhead**
  - **close to optimum with RDS**

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Conclusion

- **Idea of the Route Discovery Suppression**
  - suppress additional flooding processes
  - avoid congestion and collisions

- **Evaluation**
  - RDS: mitigates route discovery delay
  - RDS: reduces routing overhead
  - RDS: improves trade-off between overhead and reliability
  - RDS: saves energy and network capabilities

Thank you for your attention!

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