Toward Broadcast Reliability in Mobile Ad Hoc Networks with Double Coverage

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Outline

- Introduction
- Related work
- Double-Covered Broadcast (DCB) Algorithm
- Simulation
- Conclusion

Introduction(1/2)

- Flooding is one of the most fundamental operations in MANET.
- MANETs suffer from a high transmission error rate because of the high transmission contention and congestion.
- Blind flooding
  - Collision--Broadcast storm problem
  - Consume a lot of energy resource

Introduction(2/2)

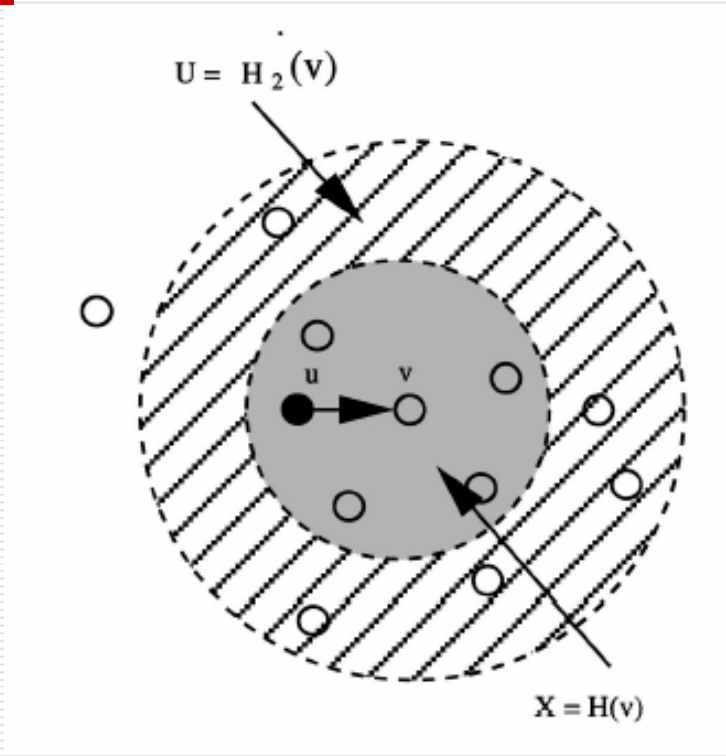
- Probability-based broadcast algorithms
  - Only provide probabilistic coverage
- We aim to provide
  - Full coverage in an ideal error-free environment.
  - High delivery ratio in a high transmission error rate environment.

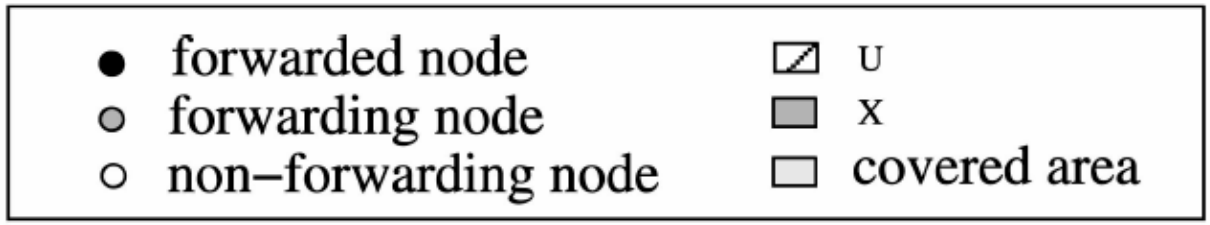
Related work(1/5)

- Neighbor-Designating-Based Broadcasting
  - Probabilistic approaches
    - Broadcast is based on probability p
  - Deterministic approaches
    - Select forwarding nodes
    - Add these forwarding nodes to the packet
    - Only these forwarding nodes need rebroadcasting

Related work(2/5)

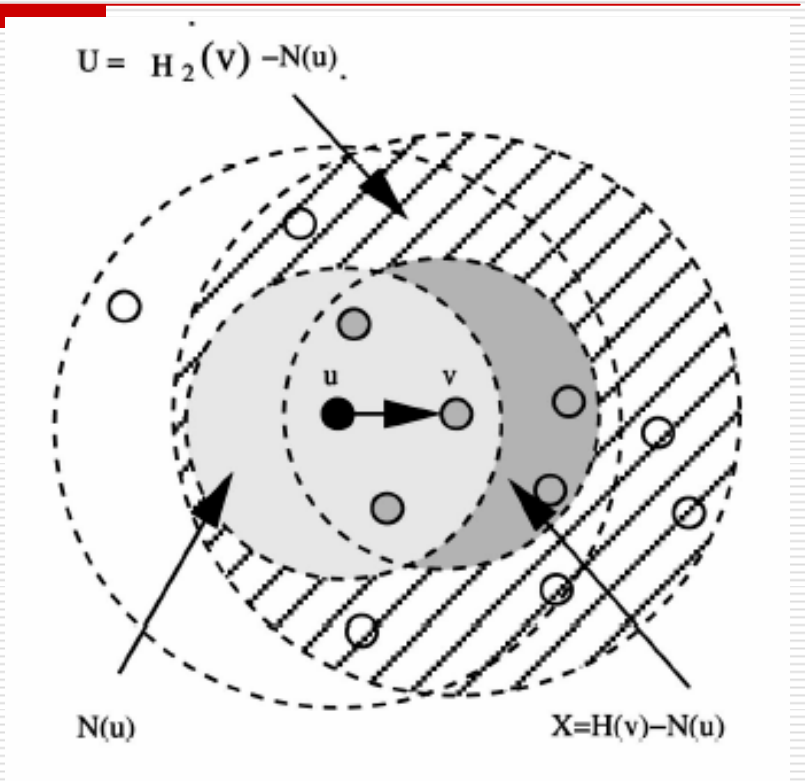
- Multipoint relays (MPRs)

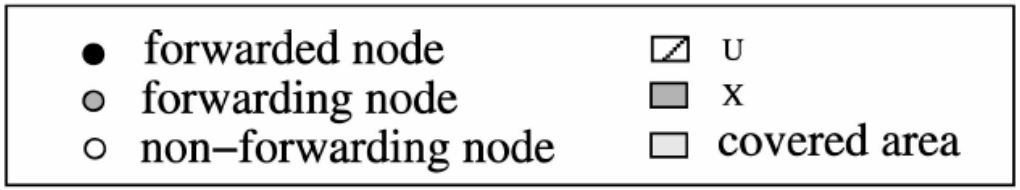




Related work(3/5)

- Dominant pruning algorithm (DP)





Related work(4/5)

- Forwarding Node Set Selection Process (FNSSP)

1. Initially, $X = H(v)$, $U = H_2(v)$, and $F = \phi$.
2. Find w (in X) with the maximum effective neighbor degree $deg_e(w) = |N(w) \cap U|$.
3. $F = F \cup \{w\}$, $U = U - N(w)$, and $X = X - \{w\}$.
4. Repeat steps 2 and 3 until U becomes empty.

Related work(5/5)

- Reliable Broadcast (RB)
  - Every node receives message will send ACK back to the sender.
  - If the sender does not receive an ACK from any of its neighbors for a predefined period, it resends the message.
  - ACK implosion problem!!

Double-Covered Broadcast Algorithm

- Forwarding nodes satisfy two requirements:
  - They cover all the sender's 2-hop neighbors.
  - The sender's 1-hop neighbors are either forwarding nodes or non-forwarding nodes covered by at least two forwarding nodes.

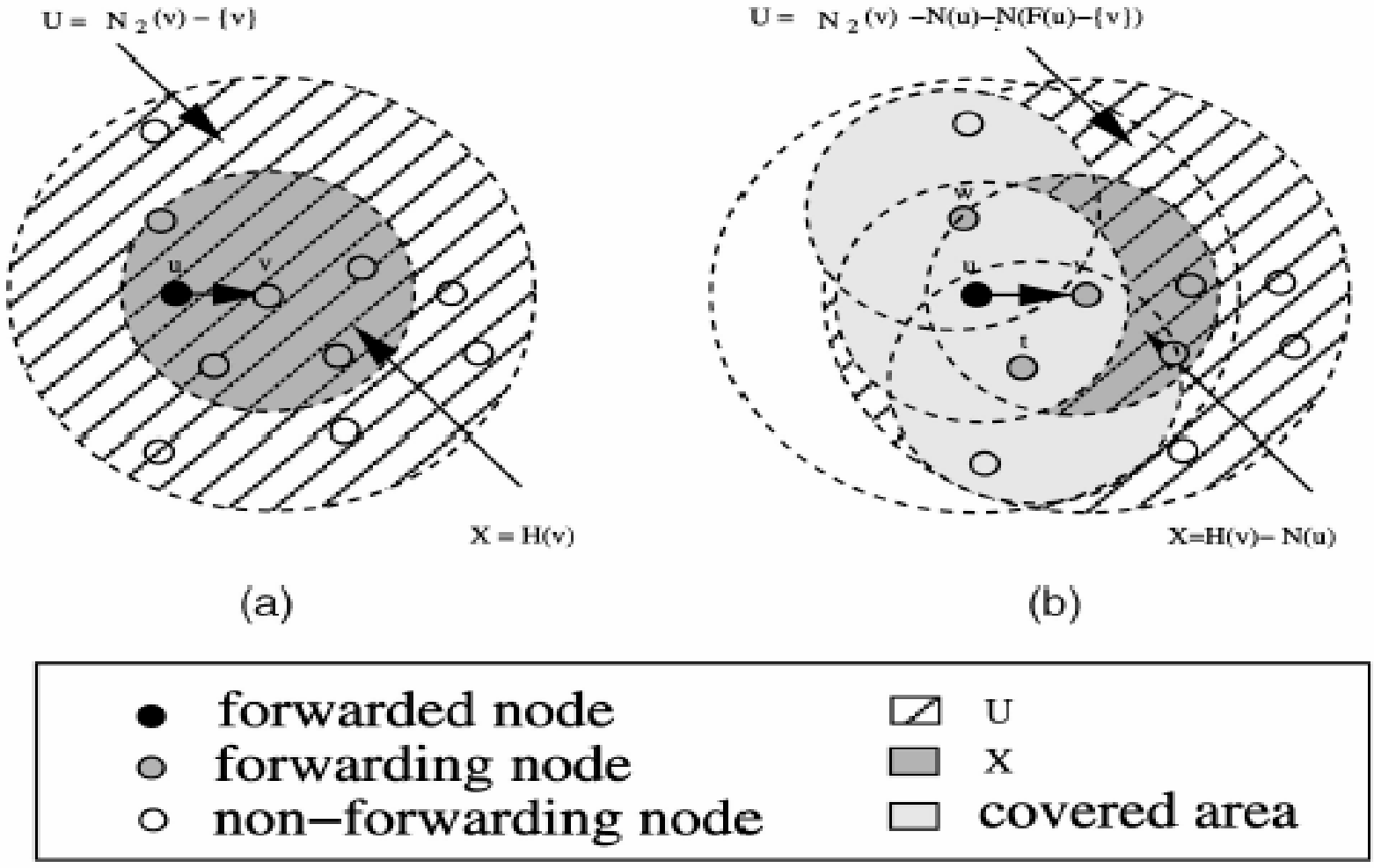


Fig. 2. Illustrations of the forwarding node set selection process of the DCB algorithm at: (a) a source node and (b) a selected forwarding node.

Double-Covered Broadcast Algorithm

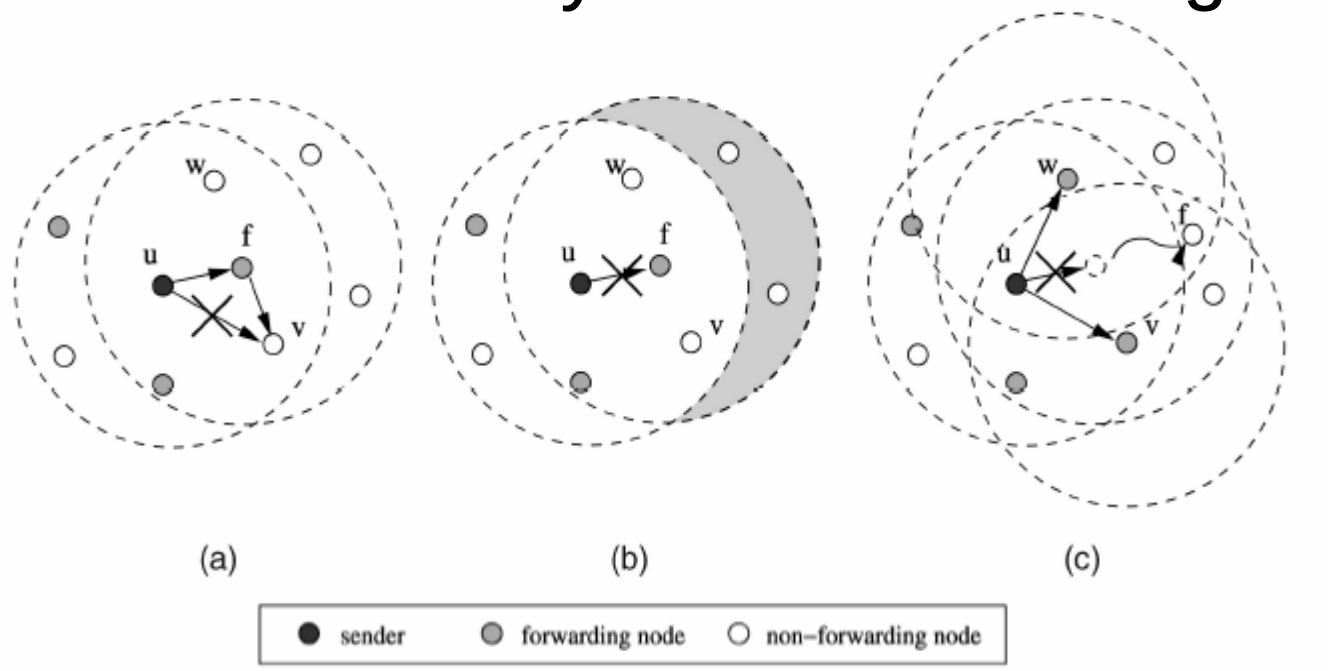
- The sender waits for a predefined duration to overhear the rebroadcast from its forwarding nodes
  - Fail to detect all => resend
  - When the maximum number of retries is reached => stop resending

Advantages of DCB

- Lower message redundancy
  - Avoid broadcast storm problem
  - Avoid ACK implosion problem
  - Packet loss can locally recover
  - Suitable for higher transmission error rate environment

Reliability issues

- Resend
- Reselect : Out-of-range movement
- Recalculate : by HELLO message



Simulation

- Parameters =>
- Movement pattern
  - Random way-point model

Parameter	Value
Simulator	ns-2 (version 2.26)
Network Area	$900 \times 900\ m^2$
Transmission Range	$250\ m$
MAC Layer	IEEE 802.11
Data Packet Size	64 bytes
Bandwidth	2 M b/s
Simulation Time	$100\ s$
Number of Trials	10
Confidence Interval	90%

Algorithm

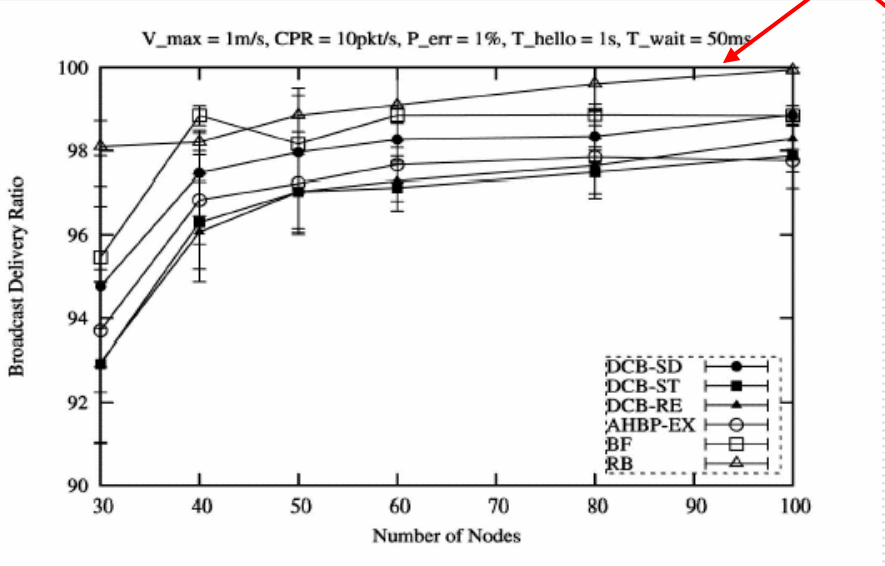
Algorithm	Description		
	Transmit	Acknowledge	Retransmit
DCB-SD	forwarding nodes	forwarding nodes	Resend
DCB-ST	forwarding nodes	forwarding nodes	Reselect
DCB-RE	forwarding nodes	forwarding nodes	Recalculate
AHBP-EX	forwarding nodes	none	none
BF	all nodes	none	none
RB	all nodes	all nodes	flooding

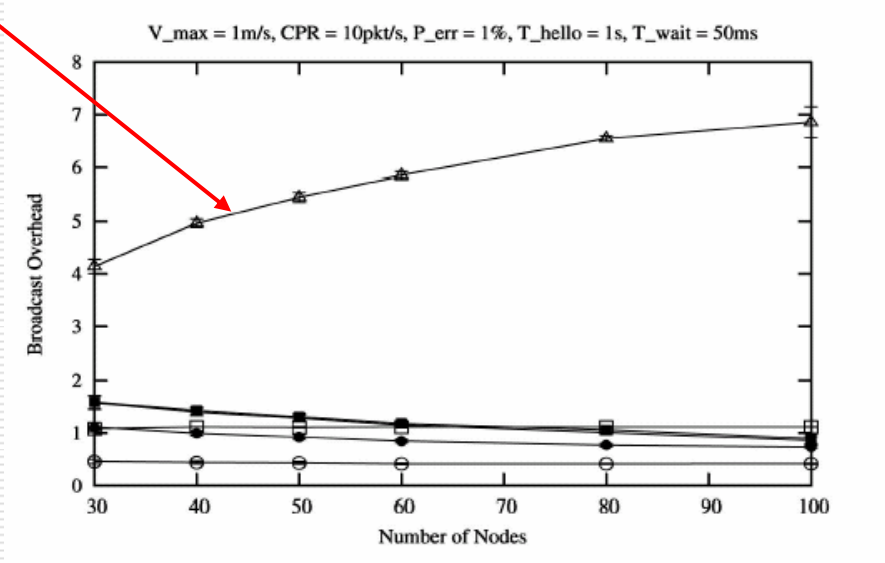
- Metrics
  - Broadcast delivery ratio
  - Broadcast forwarding ratio
  - Broadcast overhead
    - Broadcast packet + Control packet
  - Broadcast end-to-end delay

Number of nodes

Delivery ratio VS. Overhead

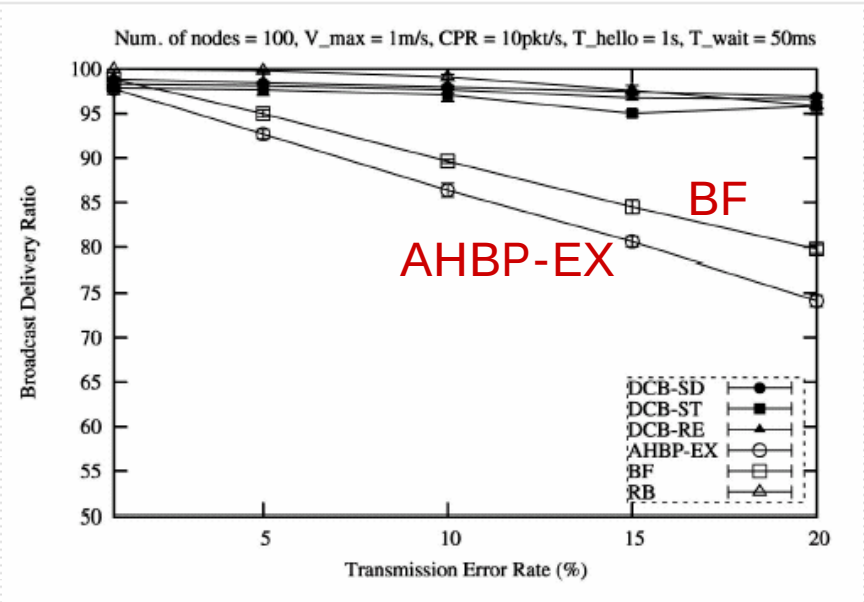
RB

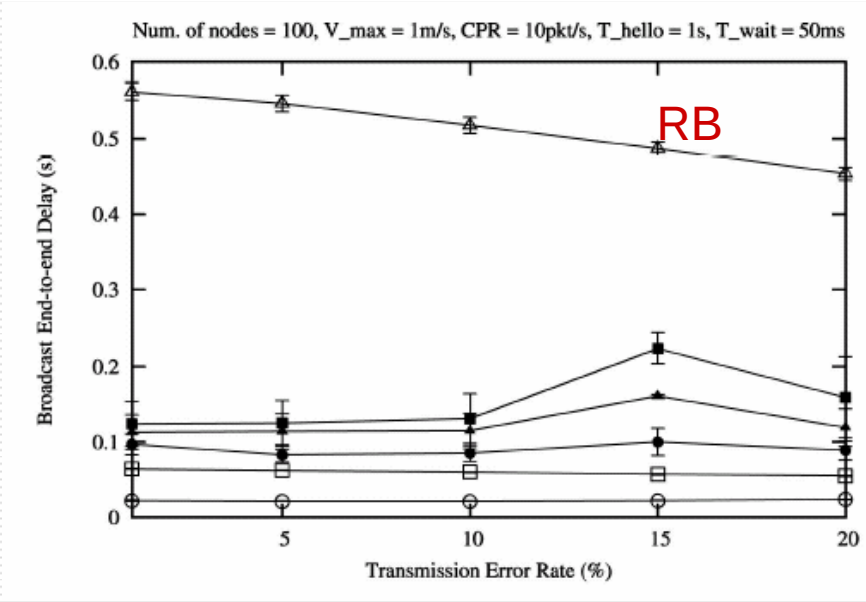




Transmission Error Rate

Delivery ratio VS. End-to-end delay

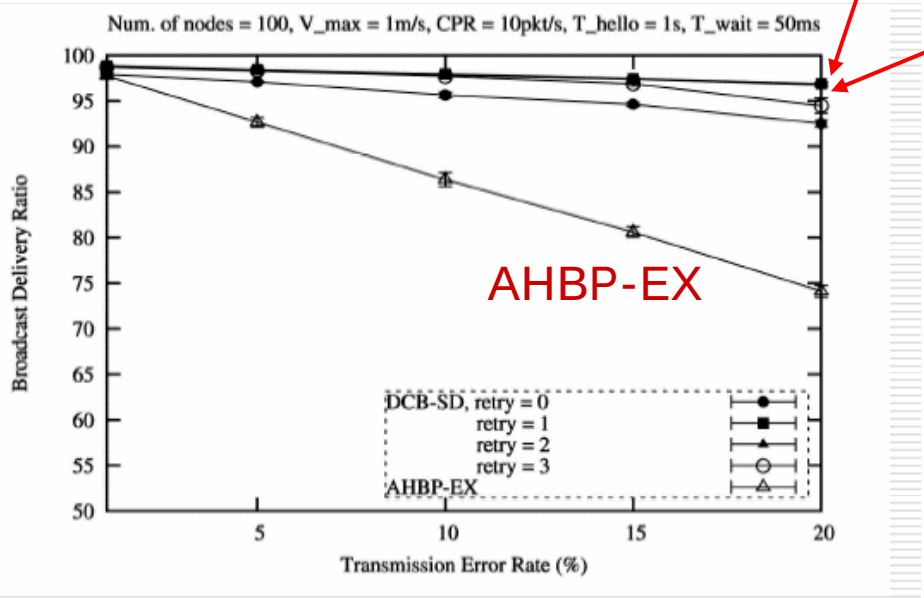


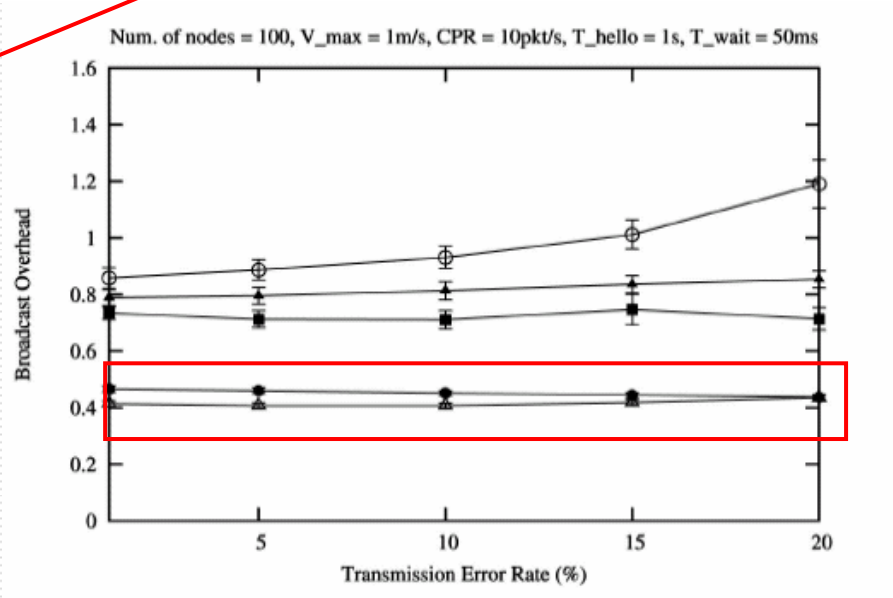


Number of retries

Delivery ratio VS. Overhead

Retry=1 Retry=3





Conclusion

- Simulation result of DCB
  - High delivery ratio
  - Low forwarding ratio
  - Low overhead
  - Low end-to-end delay
  - Suitable for high transmission error ratio environment
- Full reliability for all forwarding nodes but not for non-forwarding nodes.