Sink-to-Sensors Congestion Control Strategy

ICC2005

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Nov. 24, 2005

Outline

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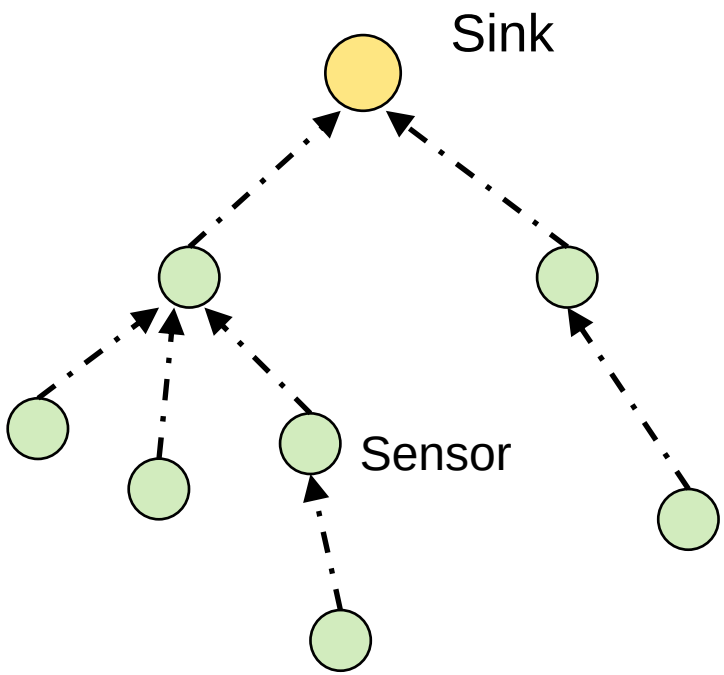
- Related Works
- Problem Definition
- CONSISE Design Elements
- The CONSISE Approach
- Performance Evaluation
- Conclusion

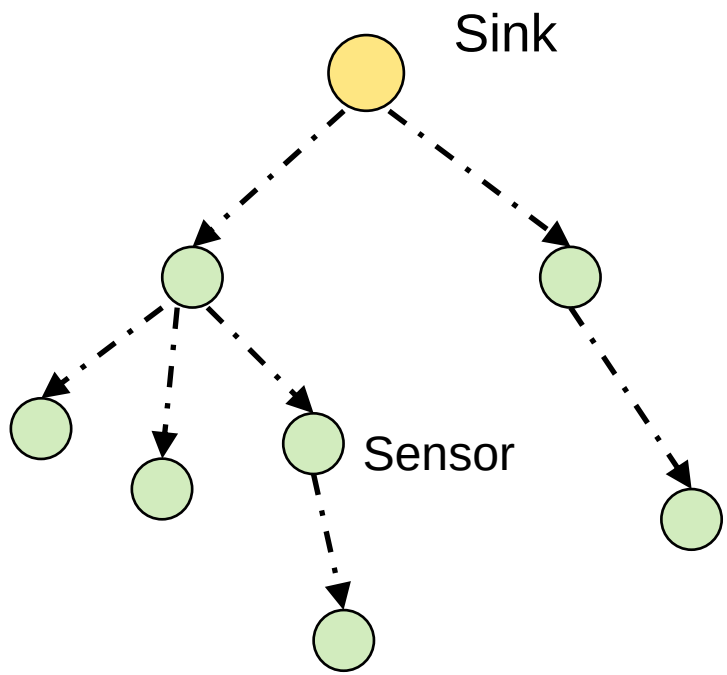
Introduction

- In military applications, it is necessary that the sink is able to transmit the data to the sensors in the least possible time.
- If we transmit at a higher data rate, we will have results in more number of collisions and packet losses.
- Congestion control is vital as it allows for fast and reliable message delivery with efficient use of available network bandwidth and energy resource of sensors.

Upstream V.S Downstream



Upstream



Downstream

Related Works

- PSFQ: distribute the data from a source node by transmitting data at a relatively slow speed.
- ESRT: is not suitable for downstream congestion control.
- CODA: when the sending rate is increased beyond a certain value, ACK feedbacks will be requested from all the sensors by the link.

Problem Definition--condition

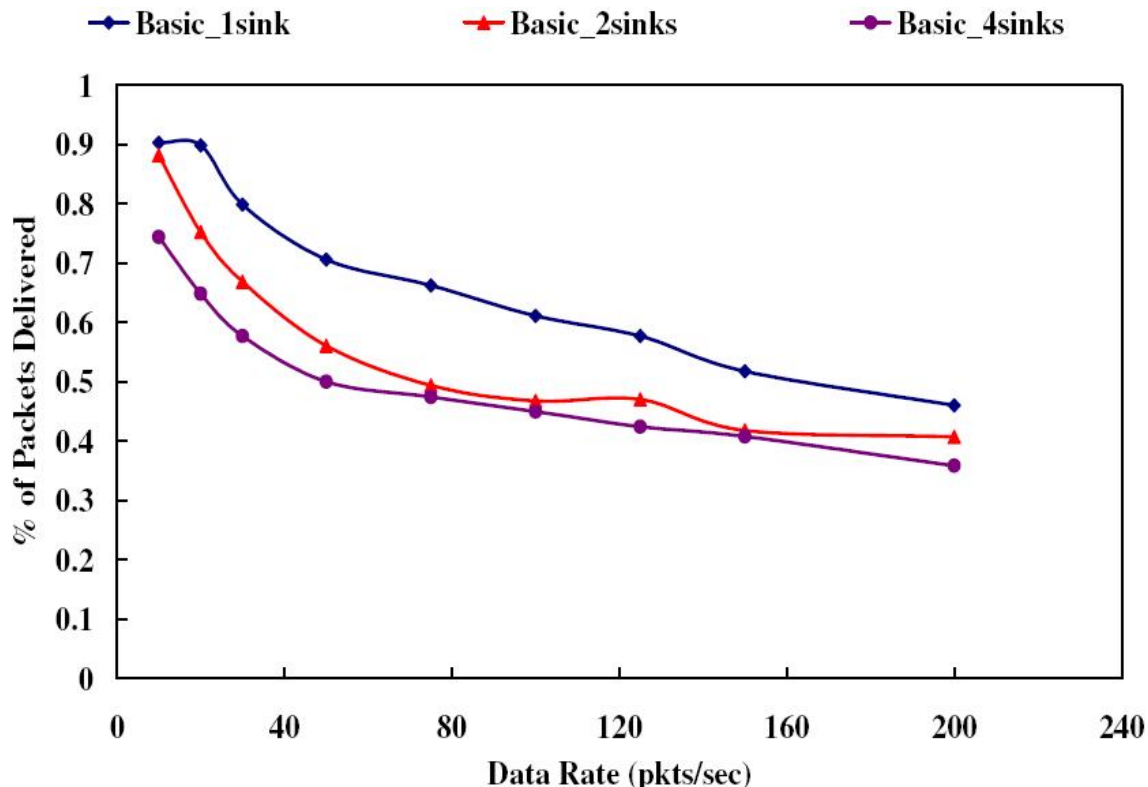
- Network Model:
  - Multi-hop WSN with one or more sinks coordinating the sensors in the field.
- Receiver Model:
  - All or only a subset of nodes are receivers for a particular message.

Our goal is to determine the *rate* at which each node will forward the packets.

Problem Definition--factors

The factors that contribute to the congestion:

- *Reverse path traffic* from the sensors to the sink.
- *Broadcast storm problem,* which refers to the higher level of contention and occurring due to a series of local broadcasts.



Problem Definition--Key Challenges(1)

- Receivers and Non-receivers
  - The resource of the receivers are utilized in an efficient way with the non-receivers participating to a minimal extent.

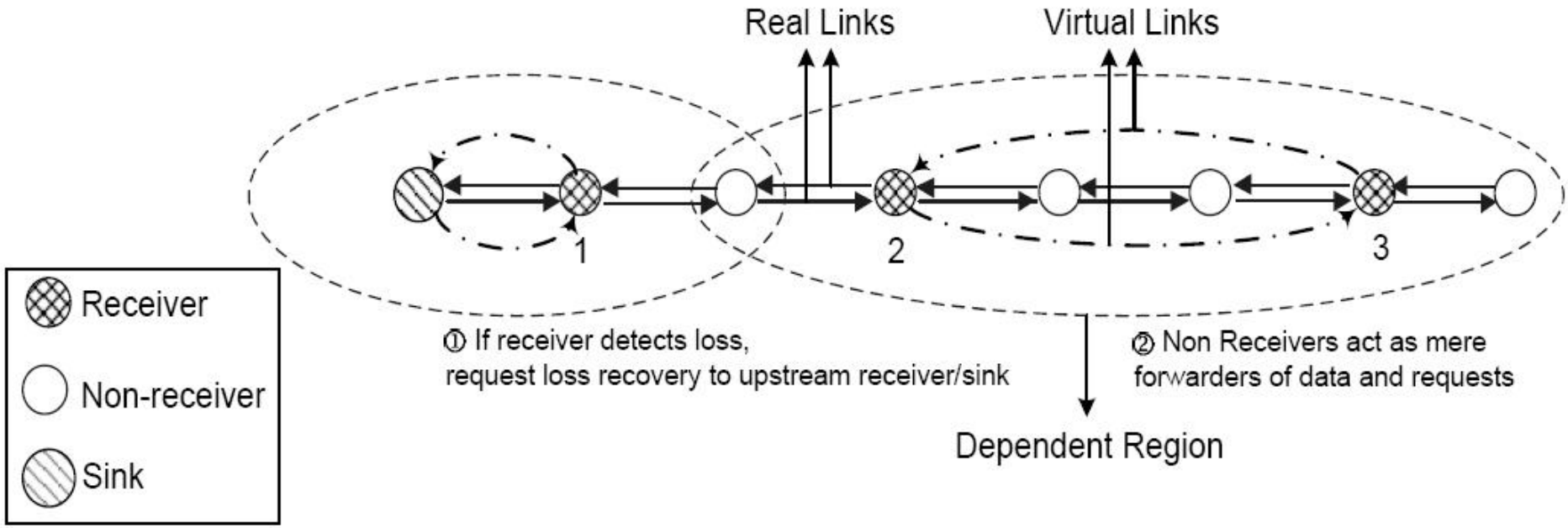


Fig. 2. Dependent Regions and Virtual Links

Problem Definition--Key Challenges(2)

- Lack of Buffering at Non-receivers
  - These nodes will act as a mere forwarders and cannot aid in retransmission of a lost packet.
- Differing Congestion Levels
  - Reverse path congestion in a localized region
  - Differences in the node density
  - Node failures
- Minimizing Delay
- Efficient Data Dissemination
- Networks Dynamics

CONSISE Design Elements

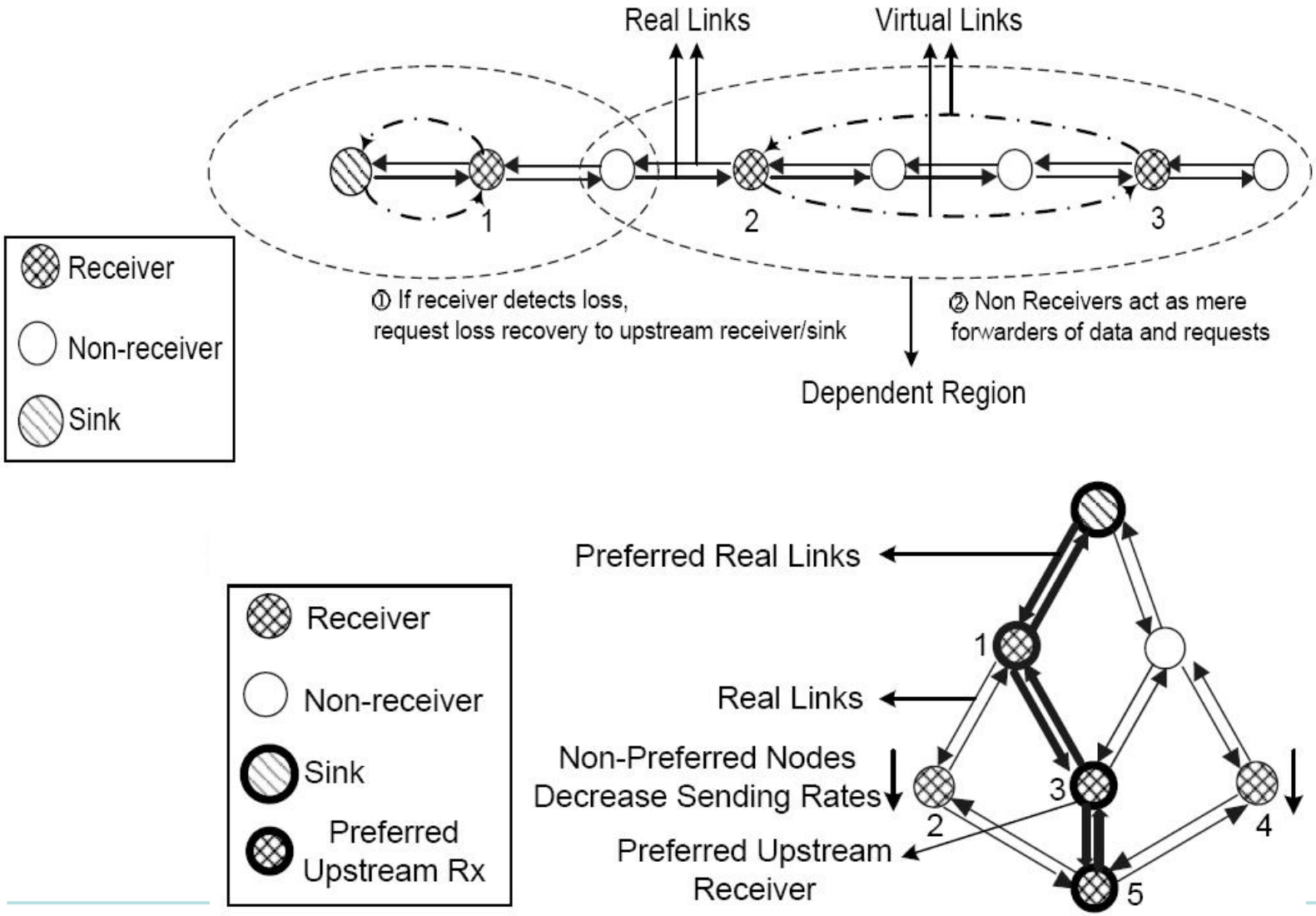
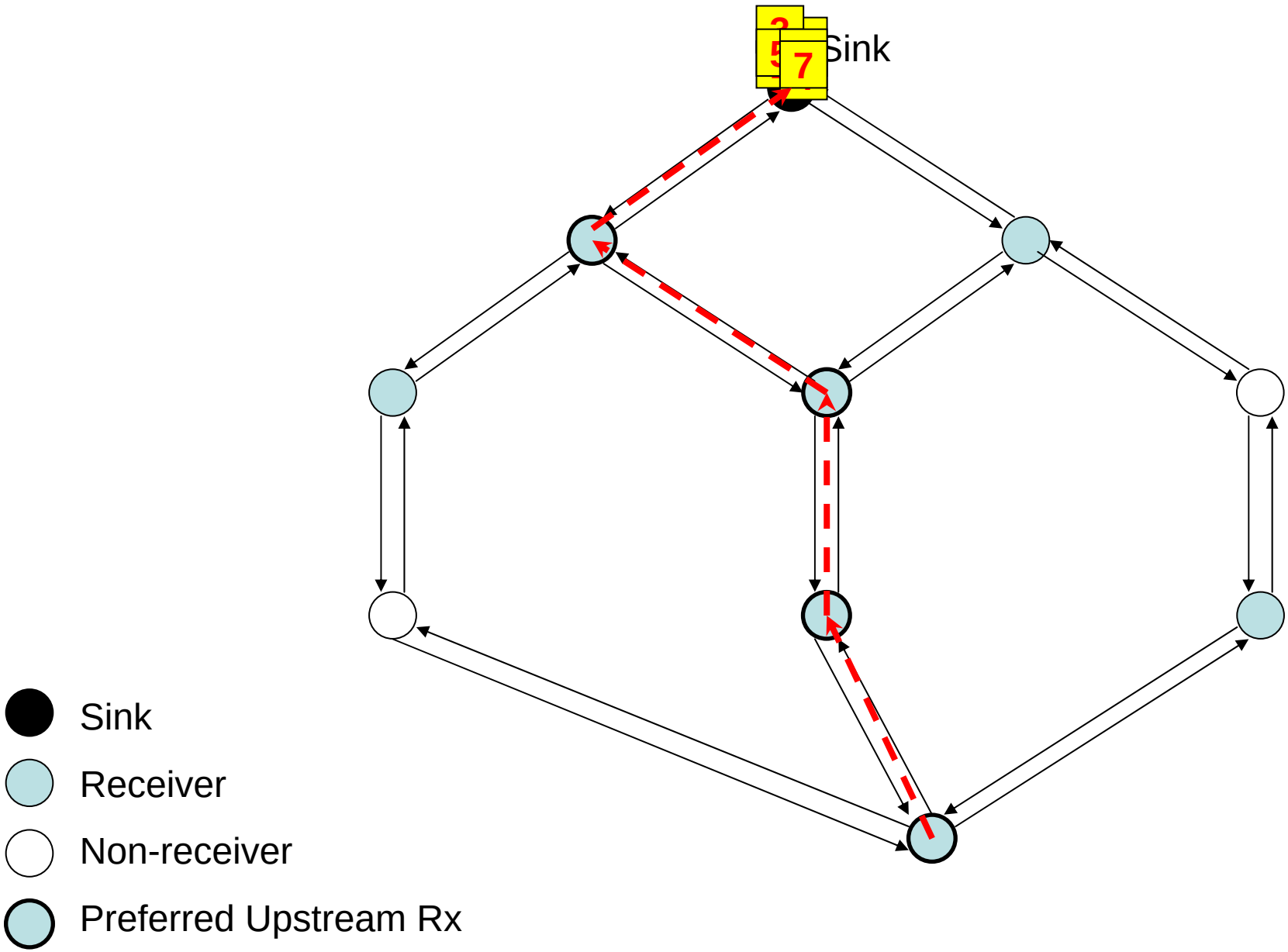


Fig. 3. Fast Reception and Selective Transmission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Sink
Sink
Receiver
Non-receiver
Preferred Upstream Rx

The CONSISE Approach--algorithm

- Transmit
- Receive
- Receive-decision
- Transmit-decision
- Notification and update

Algorithm(1)

Variable(*i*)

1. *i*:node id, *S*:send rate, R*m*:maximum receiving rate,
2. *Rk*:number of packets received,
3. S*max*:maximum possible send rate,
4. *BOT_DEP*:identifier of bottleneck dependent node,
5. *reqR*:required rate of reception.

Execution sequence

- Do
- For every packet P to be sent
- Transmit(*i*)
- For every packet P received
- Receive(i)
- While(!(epoch end))
- Receive-decision-process(*i*)
- Transmit-decision-process(*i*)
- Notification(*i*)

Algorithm(2)

Transmit(*i*)

6 Transmit every data packet with a 4-tuple

7 (*i,S,Smax,BOT_DET*)

//Each node maintains a list of upstream neighbors with the above mentioned information.

Receive(*i*)

8 For every data packet P received with 4-tuple

9 (*k,Sk,Smax-k,BOT-DEP-k*)

10 *Rk*++

11 save *Sk,Smax_k,BOT_DEP_k*

12 For every DEP-REQUEST received

13 save DEP-REQUEST

At epoch end – Notification(*i*)

30 Send DEP-REQUEST(*i,reqR*)to neighbor m

Algorithm(3)

At epoch end – Receive decision process(*i*)

14 Pick neighbor *m* with the maximum *Rm*
15 If *Rm=Sm* and *BOT_DEP_k==i*
16 then
17 *reqR*=min(*Smax_m,Rm*+1)
18 else
19 *reqR=Rm*
20 *Smax=reqR*

At epoch end – Transmit decision process(i)

21 If received any DEP-REQUEST
22 then
23 Pick neighbor b with minimum *reqR*
24 *S=reqR*
25 *BOT_DEP=b*
26 *Smax*=min(*Smax,reqR*+1)
27 else
28 *S*=max(*S*-1,1)
29 *BOT_DEP*=NOBODY

Simulation Environment

- 800 sensor nodes

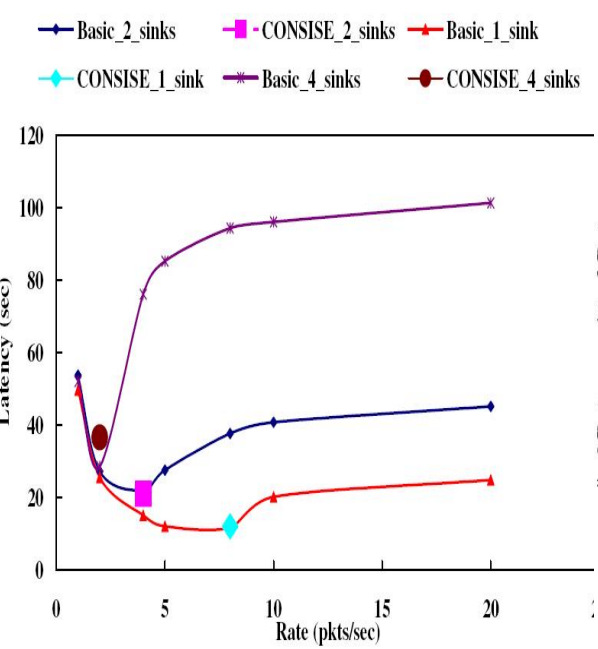
  1 sink-100/700
  - 100 nodes: placed in a grid to ensure connectivity
  - 700nodes: randomly deployed

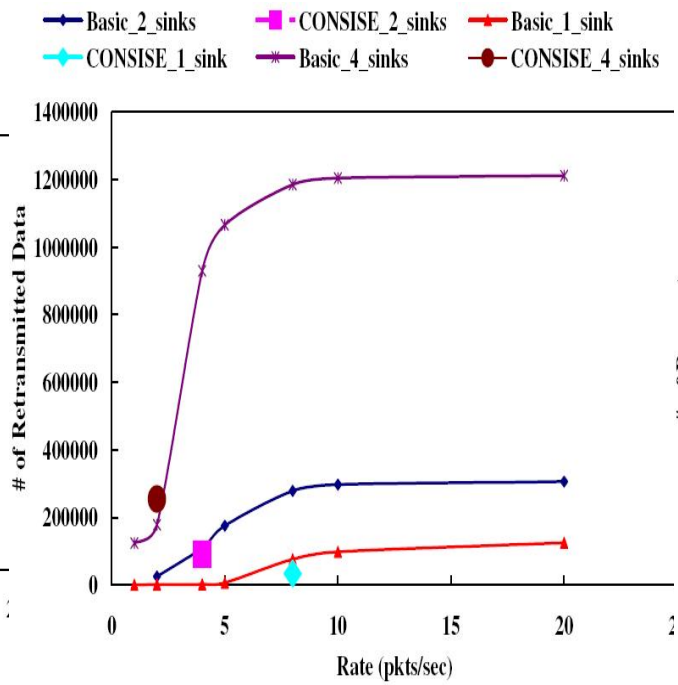
  2 sinks-100,100/300,300

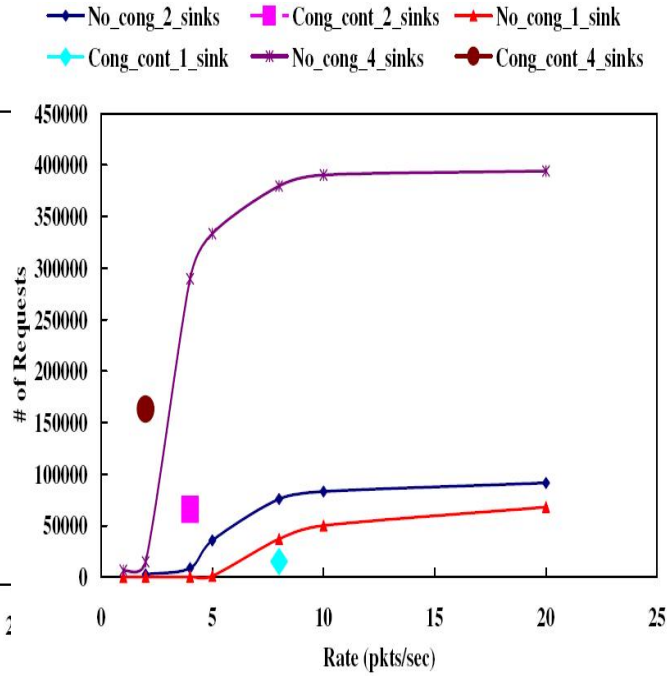
  4 sinks-100,100,100,100/100,100,100,100
- Transmission rate: 67m
- Channel bit rate: 1Mbps
- Each message consists of 100packets, each packet size is 1Kbyte.

Simulation

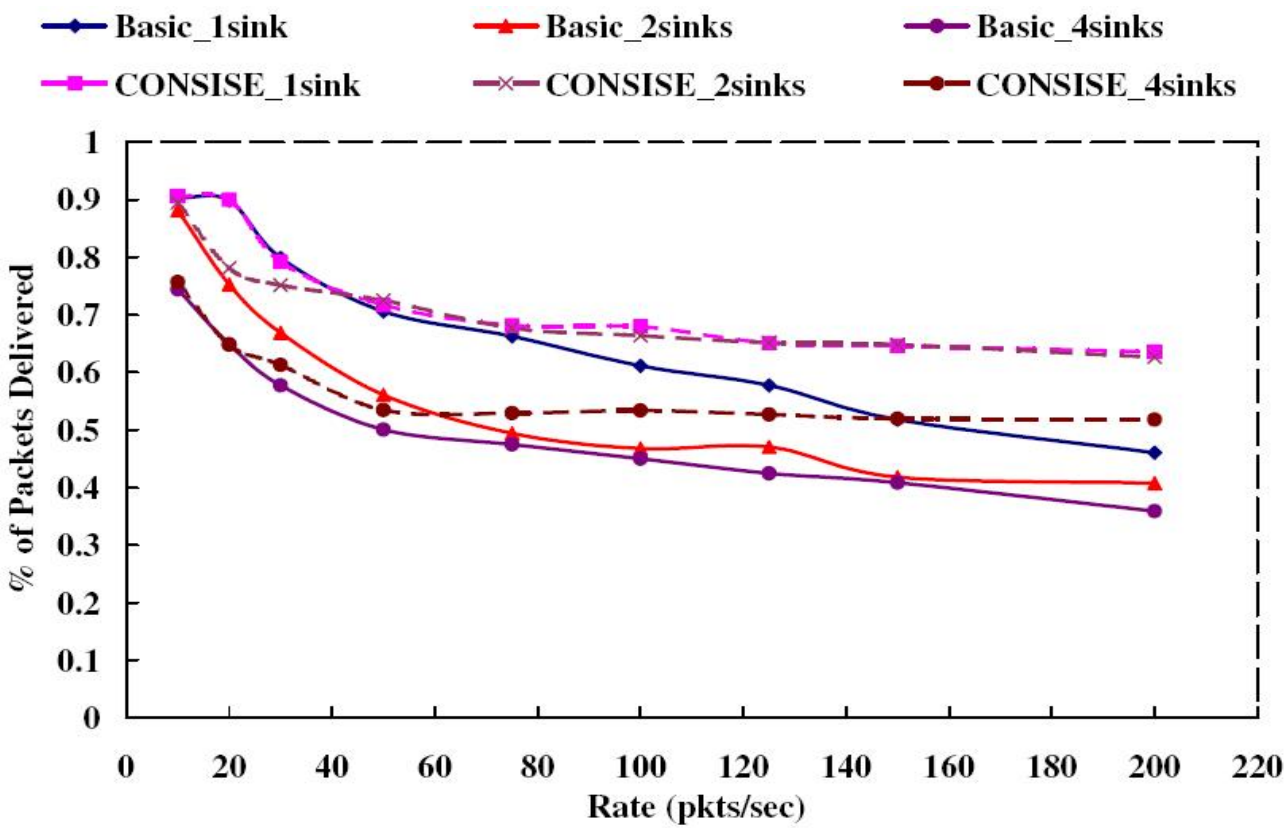
- Comparison of basic and CONSISE schemes for All Receiver Case
  - Latency
  - No. of Retransmissions
  - No. of Requests







Simulation


Basic_1sink
Basic_2sinks
Basic_4sinks
CONSISE_1sink
CONSISE_2sinks
CONSISE_4sinks
% of Packets Delivered
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
20
40
60
80
100
120
140
160
180
200
220
Rate (pkts/sec)

Conclusion

In this paper, the authors have proposed a new congestion control approach in the downstream direction for sensor networks.

They have shown through ns2 based simulations that CONSISE performs significantly better than a basic scheme, which does not provide any congestion control.