Spatial Correlation-Based Collaborative Medium Access Control in Wireless Sensor Networks

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Outline

- Introduction
- INS (Iterative Node Selection)
- CC-MAC
  - E-MAC *(Event MAC)*
  - N-MAC *(Network MAC)*
- Simulation Results

Introduction

- Idea: it may not be necessary for every sensor node to transmit its data to the sink
- CCMAC aims to reduce the energy consumption by exploiting spatial correlation in WSN without compromising the latency and the distortion achieved
- $$D_E(M) = \sigma_S^2 - \frac{\sigma_S^4}{M(\sigma_S^2+\sigma_N^2)}\left(2\sum_{i=1}^{M}\rho_{(s,i)} - 1\right) + \frac{\sigma_S^6}{M^2(\sigma_S^2+\sigma_N^2)^2}\sum_{i=1}^{M}\sum_{j\neq i}^{M}\rho_{(i,j)}. \quad (11)$$

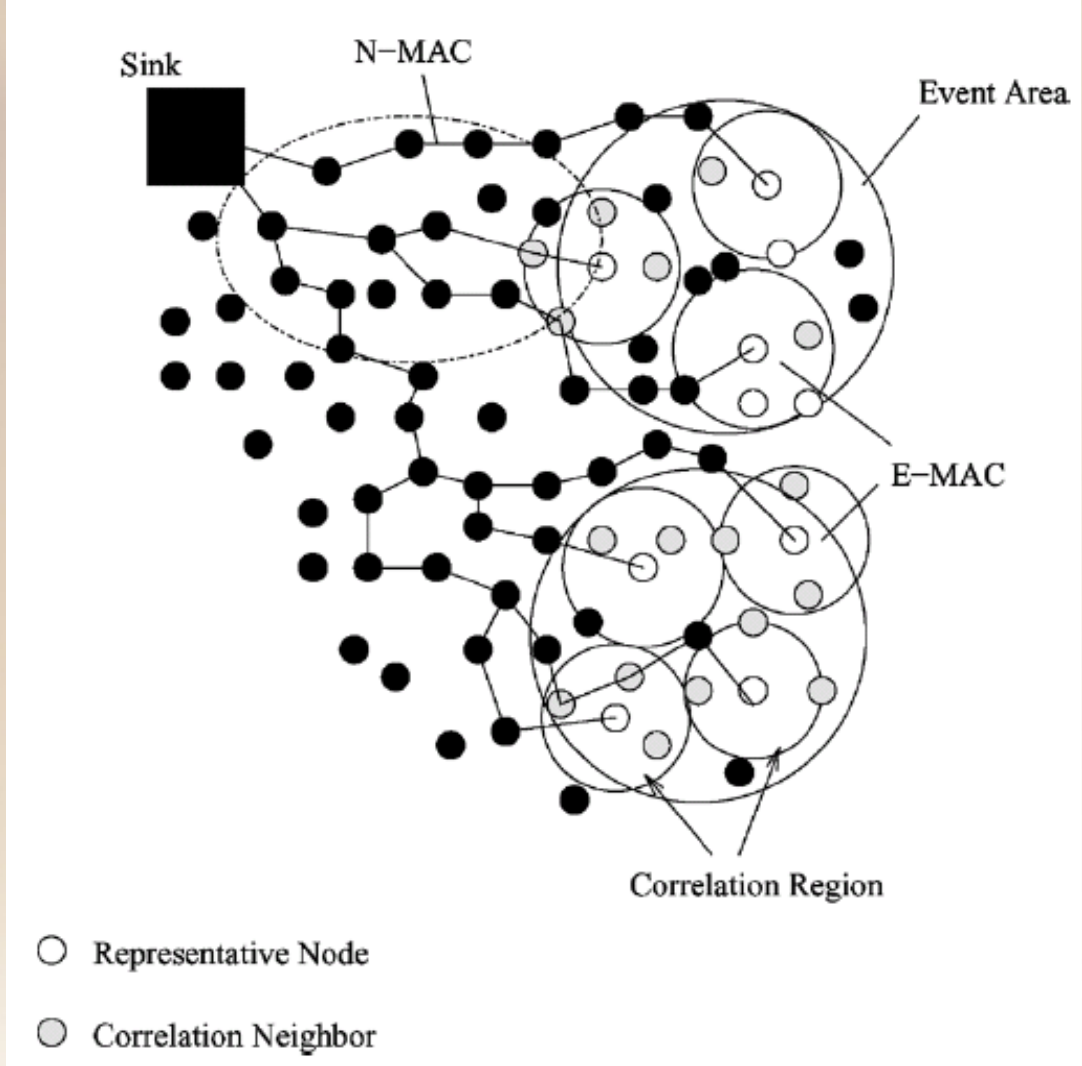
INS (Iterative Node Selection)

- Run at sink
- Input : statistical properties of the node distribution
- Output : correlation radius(r_{corr}) for distributed operation
- Correlation region
- Representative node
- Correlation neighbor

CC-MAC

- Implemented at each sensor node
- It is performed when
  - Source Function ⇨ E-MAC
  - Router Function ⇨ N-MAC
- E-MAC
  - Filter out the correlated records
- N-MAC
  - Ensure prioritization of route-thru packets

CC-MAC


Sink
N−MAC
Event Area
E−MAC
Correlation Region
Representative Node
Correlation Neighbor

CC-MAC

- Packet structure
  - FH: to differentiate the type of packet

RTS Packet Structure

	Frame Control	Duration	RA	TA	*FH*	FCS
Bits	16	16	48	48	1	32

CTS Packet Structure

	Frame Control	Duration	RA	*FH*	FCS
Bits	16	16	48	1	32

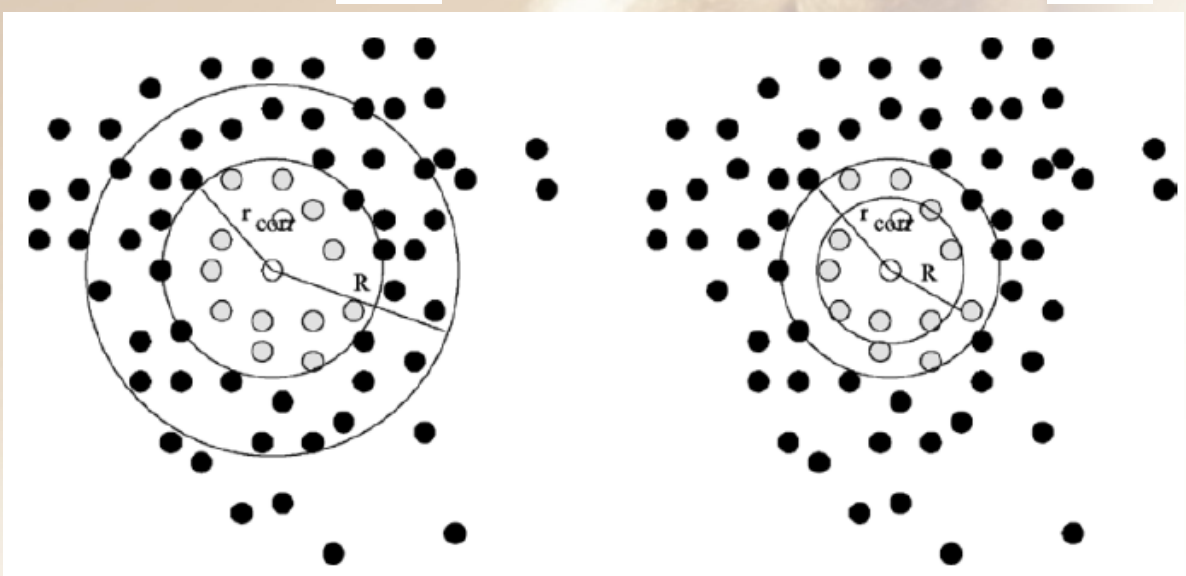
DATA Packet Structure

	MAC Header	*FH*	Frame Body	FCS
Bits	240	1	0–18496	32

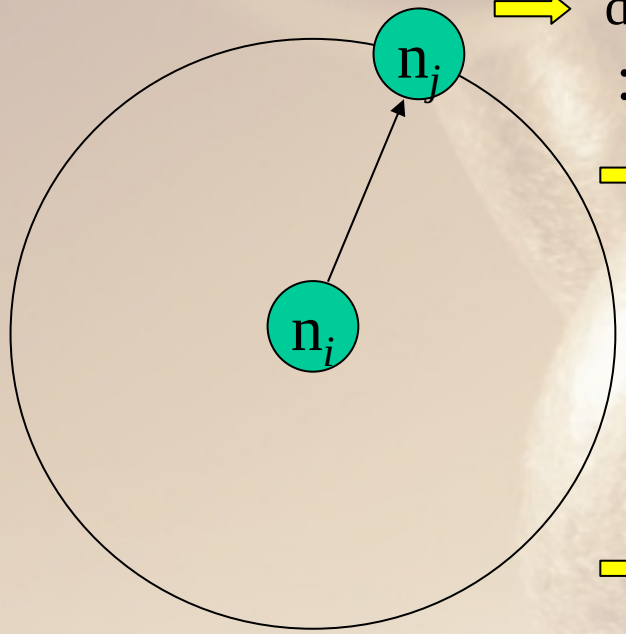
CC-MAC

- E-MAC *(Event MAC)*
  - Filter out the correlated records by forming correlation regions based on r_{corr}
  - FCP *(First Contention Phase)*
  - Two cases

Case1: R> r_{corr} Case2: R< r_{corr}



CC-MAC



➡ d(i,j) < r_{corr}

: n_j *is* n_i*'s correlation neighbor*

➡ Enter SSS *(Suspicious Sleep State)*

T_{SSS}

➡ T_{tx}

$T_{tx} < t_{rs} < T_{nextTx}$

➡ After t_{rs} , *listen for EIFS*

T_{nextTx} *: the time when node* n_i *will begin the next transmission*

t_{rs} *: random sleep interval*

CC-MAC

- Case2: R < r_{corr}
  - Problem1 : there is a tradeoff between correlation filtering and protocol overhead
  - Problem2 : the routing of node n_i ‘s packets out of the correlation region

    ⇨ *directional sleeping technique*

CC-MAC

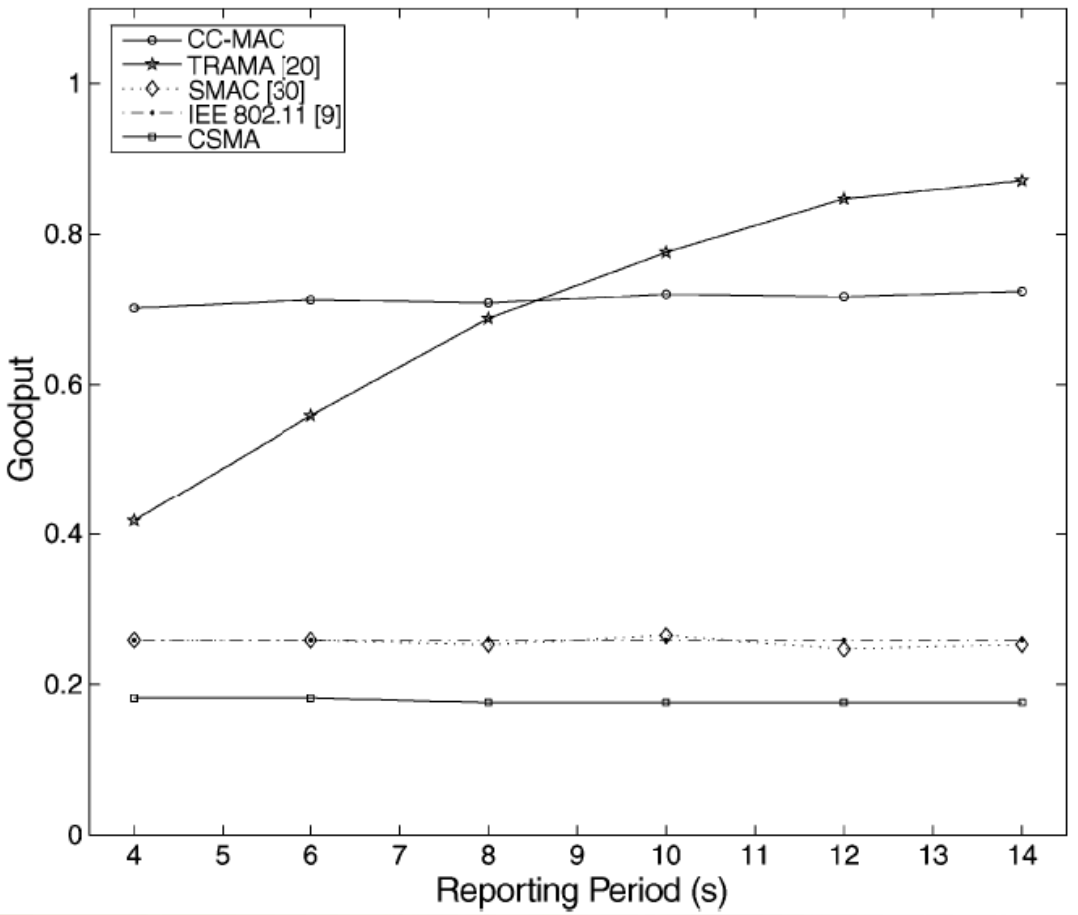
- N-MAC *(Network MAC)*
  - Ensure prioritization of route-thru packets
  - *PIFS < DIFS*
  - *PIFS : node with route-thru packet*
  - *DIFS : node performing E-MAC*

Simulation Results

- Ns2
- 50 nodes
- 500 * 500 m^2
- Transmission range: 100 m
- Each time last for 600s

Simulation Results

- Goodput $\frac{\text{received}}{\text{generated}}$



Simulation Results

- Average energy consumption