



AGGREGATE QUANTITIES and WIDOM

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Outline

- Data aggregation in wireless sensor networks
- WiDom
 - Overview
 - Operation
 - Difficulties and Improvements
- Using WiDom for aggregate quantities
- WiDom in multiple broadcast domain
- Discussion and Future works



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Data Aggregation in WSNs

- Data aggregation shall not hide statistical information about the event
 - Number of reporting nodes \Rightarrow event's size
 - Timing of reports \Rightarrow event's dynamics
- Two approaches:
 - With size reduction
 - Some processing such as Average
 - Reduce the Accuracy!
 - Without size reduction
 - Merging without processing
 - Recoverable



Protocols and Functions

- Routing protocols
 - For data gathering, each parent node waits for
 - a predefined time or
 - hearing from all of its children or a timeout or
 - an adjustable timeout based on node's position
- Aggregation function
 - Lossy or lossless
 - Duplicate sensitive or insensitive

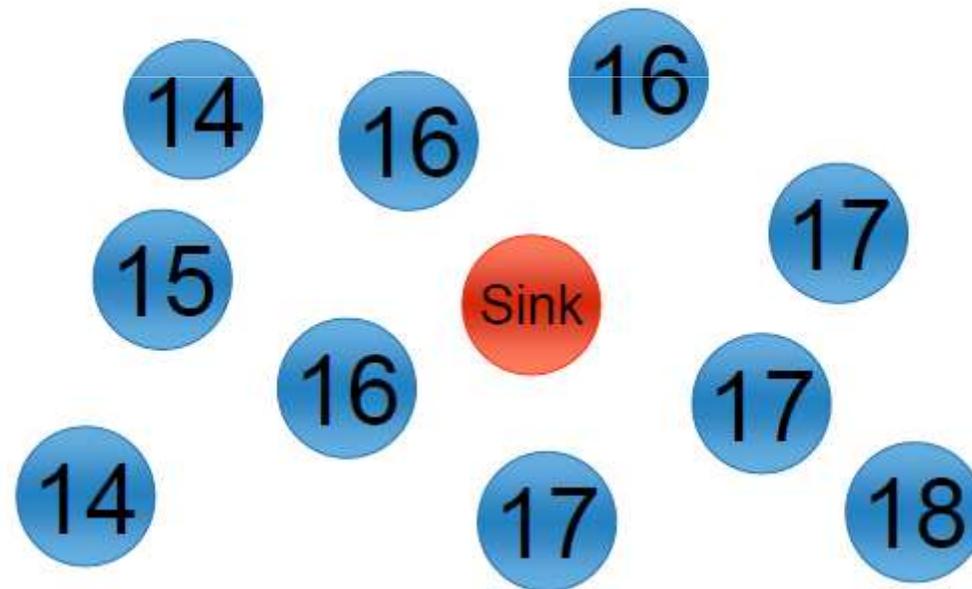


Networking Protocols and Hierarchies for Data Aggregation

- Tree-based approaches
 - TAG, Directed Diffusion, PEGSIS, DB-MAC
- Cluster-based approaches
 - LEACH, COUGAR
- Multipath approaches
 - Synopsis Diffusion
- Hybrid approaches

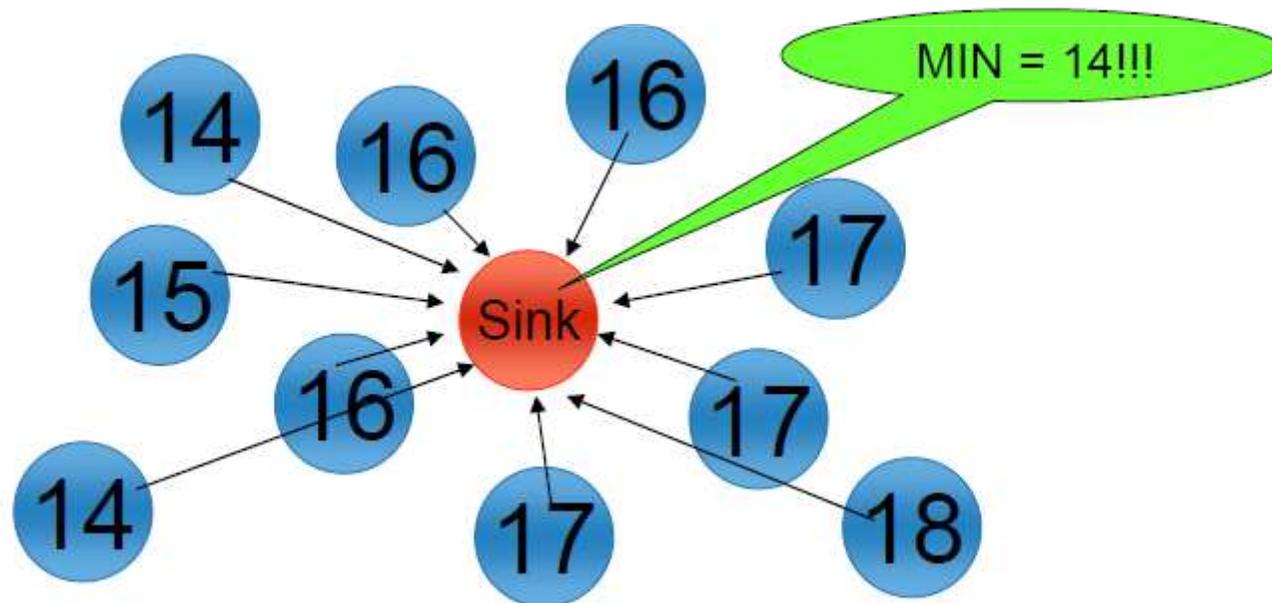
Accessing the Medium

- What happens when the nodes want to send their data to their parent (or cluster head)?



Accessing the Medium

- Time-complexity as a function of number of nodes (no scalability)





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WiDom: Overview

- A new MAC protocol for Wireless Networks
 - To Share channel for sporadic message streams
 - To meet real-time deadlines
 - To have priority scheduling
 - With large number of priority levels
 - Fully distributed
 - Based on CAN* bus

*Controller Area Network

CAN bus

- Belongs to family of Dominance/Binary countdown Protocols
 - Nodes should be able to monitor the medium while transmitting
 - Implementation based on wired-AND
- It is Possible to compute upper bound on message delay



Dominance/Binary countdown Protocols

- Nodes (messages) are assigned unique priorities
- Nodes wait for a predetermined time until the channel is idle
- Arbitration
 - Sending priority, bit by bit starting from MSB
 - Monitoring the medium at the same time
 - Node contends with recessive bit, refrains from the contention, if hears dominant bit



WiDom: Wireless Dominance based protocol

- Transmissions should be accomplished
 - Before deadlines
 - Without any collision of “data bits”
- Nodes are in a single broadcast domain
 - No hidden terminal exists
- Key point:
 - No need to sense the medium while transmitting
 - Offer an upper bound on the response time

WiDom: Operation

- Synchronization
 - For agreeing on the start time of tournament
- Transmitting priority bits
 - Starting with MSB
 - Dominant bits: sending carrier
 - Recessive bits: just listening
- Winner sends payload



Difficulties of Wireless Implementation

- Many transceivers not designed for frequent switching
 - Non-negligible switching time
- Higher noise level of wireless channel
 - Difficult to detect short duration pulses



Improvements on WiDom:

- Two independent radio modules with a high frequency switch
 - Low switching time
 - Transmitting carrier wave for a short duration of time
- A master node send pulses on a separate channel
 - Very accurate synchronization
 - Reduce waiting time
 - Able to synchronize multiple-broadcast domain
- More reliability
 - Bit stuffing



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Using WiDom for Aggregation Quantities

- In large-scale dense WSN
- Priority field as a function of the physical quantity to compute:
 - MIN
 - MAX
 - Interpolation
- Time complexity is independent of the number of nodes



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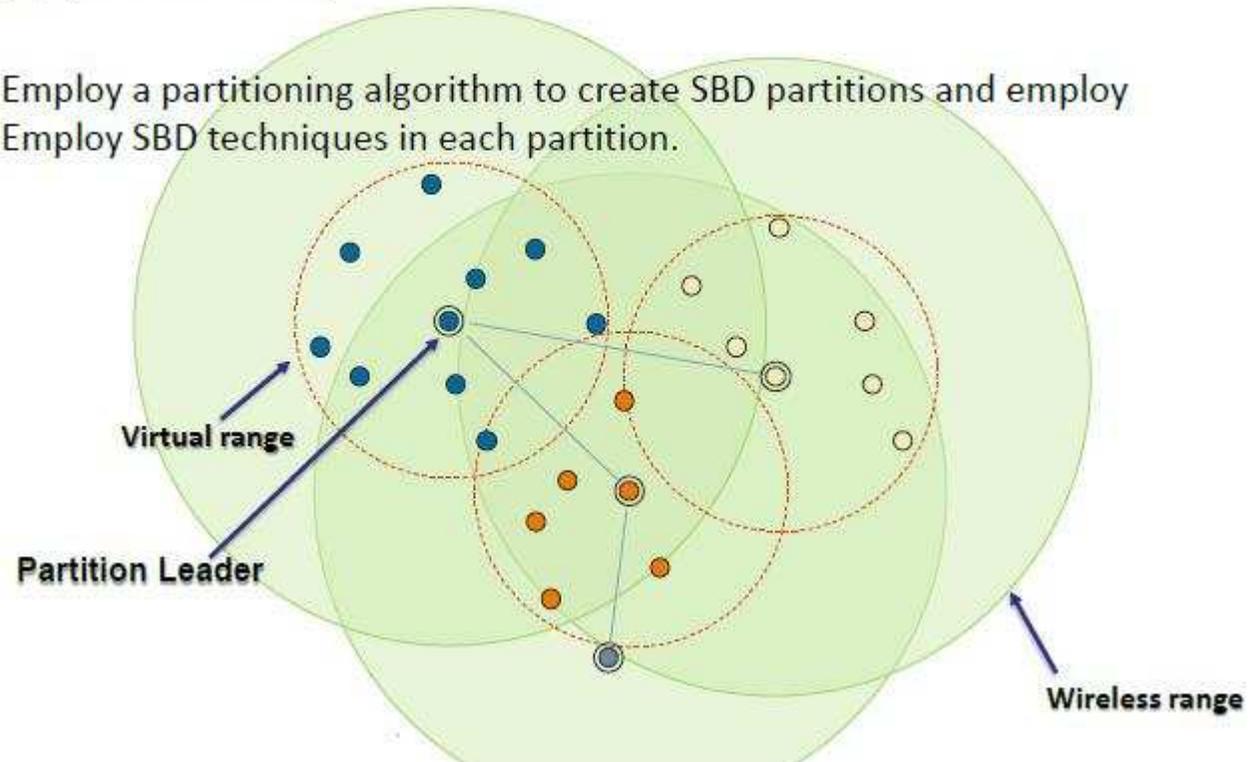
WiDom in Multiple-Broadcast Domain

- Partitioning the network to the single broadcast domains
- Selecting a leader for each partition
- Aggregation is performed in each partition
- Leaders send data to the leader of the network in predefined time slots

WiDom in Multiple-Broadcast Domain(cont.)

- Apply SBD techniques in MBDs

- Employ a partitioning algorithm to create SBD partitions and employ SBD techniques in each partition.





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Discussion

- Applications of it
- Energy Consideration
- Fault tolerance
- Scalability



Thank you!