Virtual Token-Passing MAC for UWB-based Wireless Sensor Networks

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Motivation

- Major design challenges of wireless sensor networks (WSNs)
  - Extended network lifetime, scalability, adaptability, reliability, robustness and more
- These demands can be satisfied by impulse radio

Ideas, Approach and Proposal

- The token ring MAC protocol for the wired medium (i.e., IEEE 802.5) was successful
  - Issue: relatively complex to solve the lost or multiple token problem
  - Its wireless counterpart has been out of consideration.
- PN code assignment and channel sensing are major concerns for MAC in impulse radio networks just as in SS-PRNs
- Tackling core underlying issues together, we propose a Virtual Token-passing MAC (VT-MAC) protocol for UWB WSNs

Objectives

- To meet MAC-level demands for WSNs by exploiting the underlying UWB characteristics
  - Coordinate the use of the shared medium for achieving desired goals: high energy efficiency, high throughput, and low delay
- To make the nature of spread spectrum signals beneficial in the MAC layer as in the physical layer

VT-MAC

- A parent node as a code monitor (CM) that assigns / monitors PN codes to its child nodes forming a logical cluster called a virtual ring
- PN codes act as virtual tokens (no extra tokens): virtual ring (VR) tokens and virtual signature (VS) tokens

Preliminary Results

- A VT-MAC channel capacity (i.e., maximum throughput) can be achieved above 90%
- It monotonically increases as a packet reservation cycle is increased.
- Mean packet delay remains low even when a channel utilization ratio is high
- Controllable delay / throughput bounds through the use of virtual tokens suggest that VT-MAC can potentially provide a QoS provision
- With static processing gain settings, UWB is limited to MAI as are other spread spectrum radios
- Through finding a proper ratio of two types of processing gain that impulse radio uniquely provides, a target packet reception rate can be maintained

Almost perfect packet reception rates are maintained during operation through configuring processing gain.