Project: IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)

Submission Title: Time Synchronization in Wireless Sensor Networks
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Re:

Abstract: PHY Definitions

Purpose: Document the Importance of Time Synchronization in Wireless Sensor Networks

Importance of Time Synchronization in Wireless Sensor Networks

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Outline

- Measurement Synchronization
- Synchronization for Shared Communication Medium
- Synchronization for Efficient Energy Consumption

Measurement Synchronization

- The times of occurrence of physical events are often crucial for the observer to associate event reports with the originating physical events.
- Examples of the benefit accurate time-stamping of measured quantities include
  - Acoustic leak detection mechanisms that can pinpoint the location of a leak given a known speed-of-sound through a pipe.
  - Synchro-phasor measurements where the relative phase relationship between current and voltage at various locations can be measured if an absolute time-basis is communicated to multiple end-points.
- Methods for determining location of sensor nodes based on the measurement of time of flight or difference of arrival time of certain signals also require finely synchronized time.
- ***Data Fusion -*** distributed observations into a coherent estimate of the original phenomenon requires accurate time-stamping.

Synchronization for Shared Communication Medium

One particularly important example for concurrency control is the use of time division multiplexing in wireless communication, where multiple sensors independently access the shared communication medium this is typically achieved by assigning time slots to the communicating nodes. This requires the participating sensor nodes to share a common view of physical time.

Synchronization for Energy Efficiency

- Low-energy devices require spending the majority of their life in a deep-sleep state.
- Thus, temporal coordination of the sleep periods is quite important.
  - A goal is for the power-efficient device is to wake-up as close as possible to an expected event (e.g. a mutually understood “paging” time) and go back to sleep as soon as possible.
  - Lack of tight synchronization may force the node to awaken conservatively early which can waste power.
  - Acquisition algorithms tend to consume much less energy if accurate synchronization is maintained.

Summary

- Over-the-air synchronization is key to time-stamping physical quantities which is important for many applications
- In some channelization schemes, synchronization is important for physical layer performance. Sharing a shared communication medium in the time-domain is one example.
- Low-energy devices can benefit from synchronization by minimizing the amount of time out of a deep-sleep state and by being able to reduce the amount of time required for acquisition.

Questions

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