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WPAN Proposal
TDMA-based MAC Layer

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Introduction / Overview

- This is not a proposal for a specific solution, but rather a general approach.
- The general approach is backed up by a POCD, as well as forthcoming solutions.
- Overview:
  - Requirements
  - Keys to success
  - Benefits / Issues
  - Possibilities
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Requirements

- Driving requirements include:
  - Very low power consumption
  - Very small devices (including peripherals, sensors, etc.)
  - Easy integration into devices (minimal SW)
  - Wireless, no line-of-sight limitation, networks
  - Cross-network interference tolerance
- Simplifying characteristics include:
  - Data rate requirement is relatively low
  - Range is very short

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Keys to Success

- Keep transceiver OFF
  - Duty-cycling is key to reducing average current
  - Receiver consumes as much as transmitter (approximately) in the PAN environment
- Keep the MAC simple
  - Simplicity lends itself to small finite-state machines, running at slow clock rates
  - Few gates, clocked slowly, yields target result
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TDMA meets objectives

- Time Division Multiple Access
  - Devices KNOW when to receive and when to transmit AND when they can turn OFF
  - No need for higher-order timing overlay, as in 802.11, to accomplish this primary goal.
- TDMA structure defines an operational sequence easily implemented as a finite state machine.
- Byte-oriented TDMA structure lends itself to a slow-clocking MAC implementation.
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Common TDMA Fallacies

- ***Fallacy:*** "TDMA, which requires a Hub, cannot support ad hoc, peer-to-peer networks."
- ***Truth:*** As long as any device can operate as Hub, and devices can determine when to become a Hub, this is not an issue.
- ***Fallacy***: "TDMA is inefficient in its usage of bandwidth, due to slots unused by assignee."
- ***Truth:*** Dynamic allocation can be used for highly efficient assignment of bandwidth.

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Example TDMA Structure

- High-level structure includes five components:
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-
-
-
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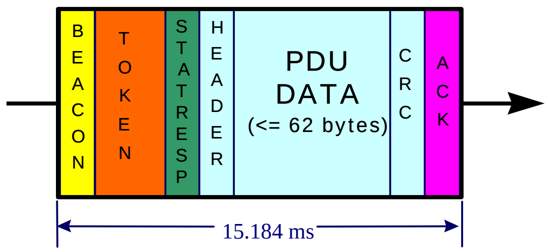

- Embedded sliding window, bandwidth allocation

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Cross-Network Interference

- Time-Based Spreading
  - Bursts can be spaced according to code patterns as in a CDMA system, but not for the same reason
  - Optical Orthogonal Coding used in BodyLAN
- Frequency Agility
- Frequency Hopping maps well to TDMA structure
- Direct sequence spread spectrum can also be applied to a TDMA-based MAC.

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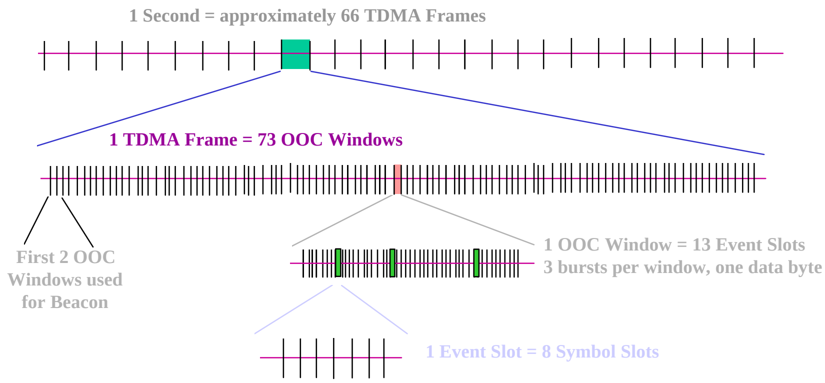
Example Low-Level TDMA

Interference tolerance, FEC, power efficiency



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Dynamic Attachment

- Devices desiring to join an existing network can listen for beacons, establish synchronization.
- Attachment can proceed via Slotted Aloha embedded within the same TDMA structure.
  - Hub can dictate how much bandwidth allocated to the support of attaching devices
  - Attaching devices do not interfere with operational ones
- Assorted mechanisms can be used to direct attachment to the desired networks.

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Example Numbers

- BodyLAN base numbers:
  - Active digital (MAC Layer): 100µA
    (few gates, clocked very slowly)
  - RF transceiver: 130µA – 2.7mA – 14mA
    (base-level current, stand-by, transmit/receive)
- BodyLAN, full data rate Hub: 5.4mA average
- BodyLAN, half data rate device: 2.8mA average
- Staying attached without sleeping: 790µA

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