

UWB Wireless Sensor Networks: UWEN - A Practical Example

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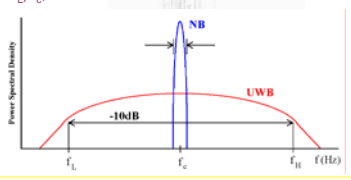
Introduction

- FCC released commercial use of UWB '02
- Impulse-radio-based UWB properties:
 - Low complexity
 - Low cost
 - Low power consumption
 - Noise like signal
 - Resistant to severe multipath and jamming
 - Good time domain resolution

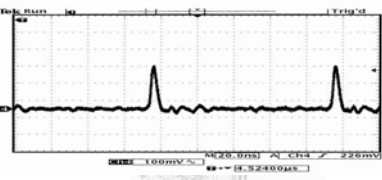
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UWB Definition

- Common Definitions
 - UWB: Fractional bandwidth = $(f_H - f_L)/f_c > 25\%$ or total BW > 1.5 GHz.
 - Narrowband: $(f_H - f_L)/f_c < 1\%$.
- FCC Definition of UWB
 - Fractional bandwidth (measured at the -10dB points), $(f_H - f_L)/f_c > 20\%$ or total BW > 500 MHz.



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UWEN(Multihop UWB Sensor system)

Finnish ski resort in vuokatti, Kainuu

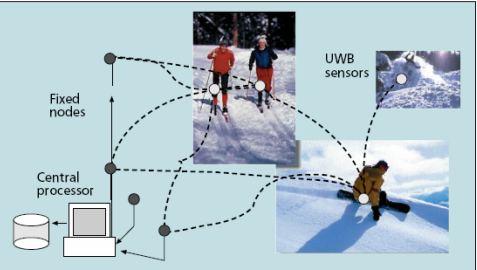


FIGURE 1. Multihop sensor network architecture.

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Performance Requirement

	Update rate (per second)	Location accuracy [+/-]	Tracking accuracy [+/-]
No hops	5	1 m	0.5m
One hop	1	2 m	1 m
Two hops	1	10 m	5 m

TABLE 1. Target system performance.

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UWB used in the project

- Non-coherent modulation
- Bit Position Modulation (BPM) combined with Direct Sequence (DS)



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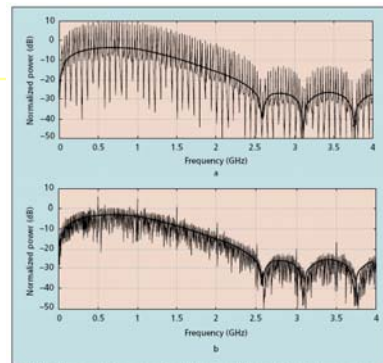


FIGURE 2. Spectrum of an example pulse train a) without and b) with randomizing techniques.

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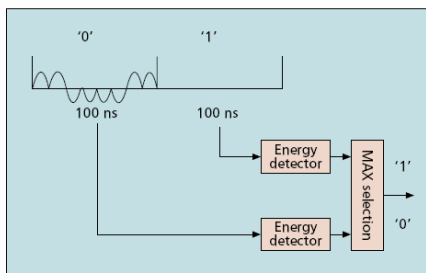


FIGURE 3. The bit decision process.

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Positioning

- TDOA
 - 2D positioning: 3 sensor, 2 TDOAs
 - 3D positioning: 4 sensor, 3 TDOAs
- Non-iterative positioning method
 - Fast, good for initial position estimate
- Iterative positioning method
 - More Accurate, time consuming
 - Optimization Based Method
- UWEN
 - TDMA: TOAs are collected, used to estimate position and store at central DB in which it can be accessed online
 - update e.g. every 1s

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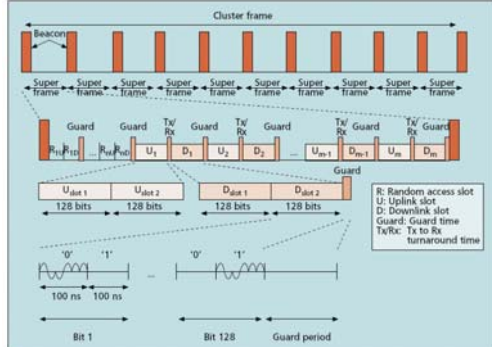


FIGURE 4. UWEN packet structure.

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MAC protocol

- Design to support ~ 1000 nodes with 10 fixed nodes in a cluster
- NanoMAC
 - Uses cluster-based fixed nodes with known location to send TDMA beacon
 - Applied to UWB using energy sense multiple access with collision avoidance (ESMA/CA)

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Energy efficient

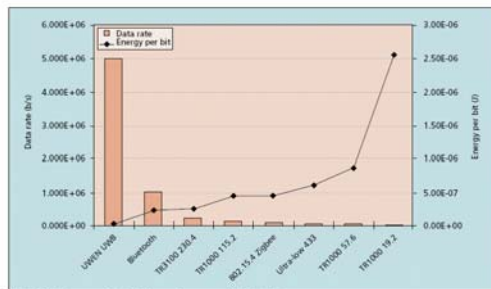


FIGURE 5. Energy per bit for different low-power RF technologies.

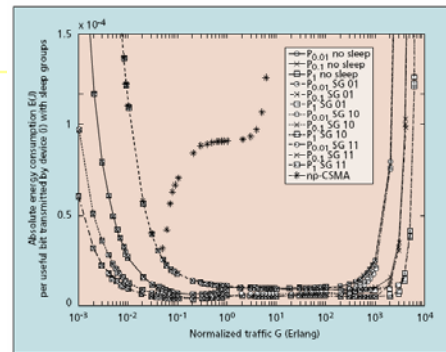


FIGURE 6. Sleep mode power for nanoMAC.

- Good point
 - Provide a broad view of UWB
 - Practical example
- Weaknesses
 - Not clear
 - Lack of references in some issues