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Cognitive radio for wireless body area networks based on UWB in hospital environments

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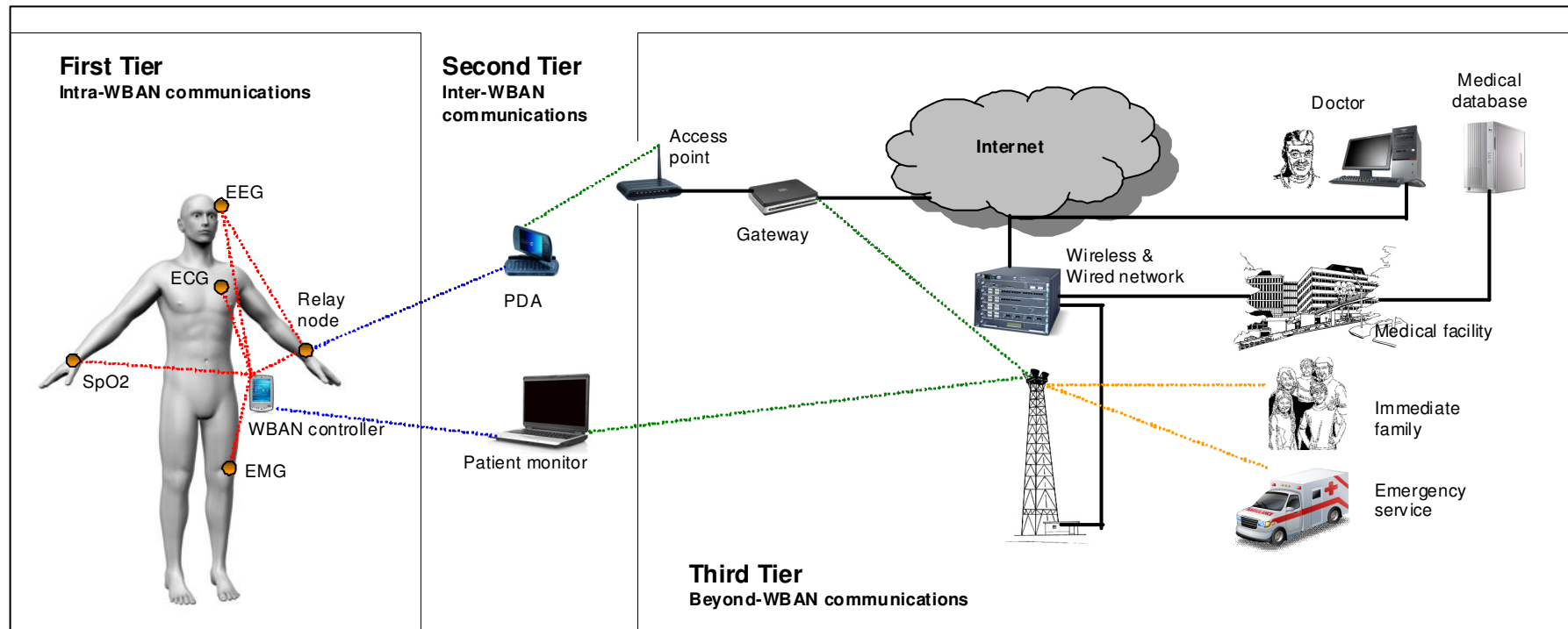


NTNU - Trondheim
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Presentation outline

- Telemedicine system
- Ultra wideband (UWB) for WBANs
- Some useful characteristics of orthogonal frequency-division multiplexing (OFDM)
- Interference and cognitive radio (CR)
- Proposed architecture of a cognitive UWB network controller
- Ideas for cognitive media access under this proposal
- Questions

Telemedicine communication systems



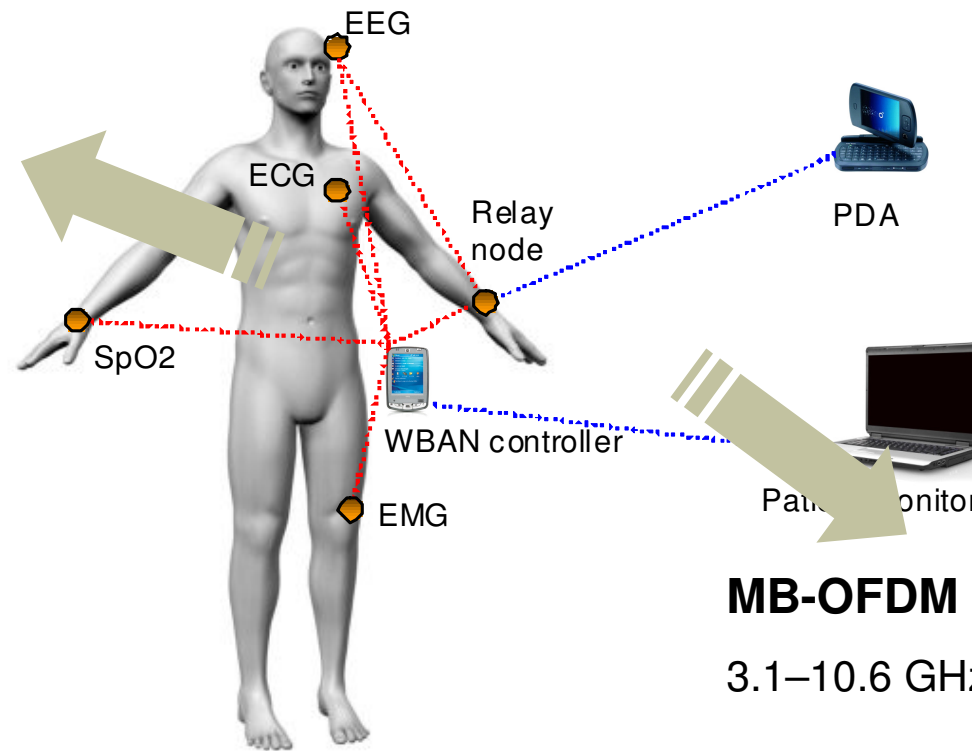
Ultra wideband for WBANs

- **Impulse Radio (IR)** for intra-WBAN communications
 - On-off keying (OOK) modulation
 - Operation in the lower part of the UWB frequency band (3.1–4.8 GHz)
 - Simple electronics
- **Multiband orthogonal frequency-division multiplexing (MB-OFDM)** for inter-WBAN communications
 - Compliance with the ECMA-368 standard (wireless USB)
 - Operation in the whole UWB frequency band (3.1–10.6 GHz)
 - Much more complex electronics

UWB radio interfaces

IR-UWB

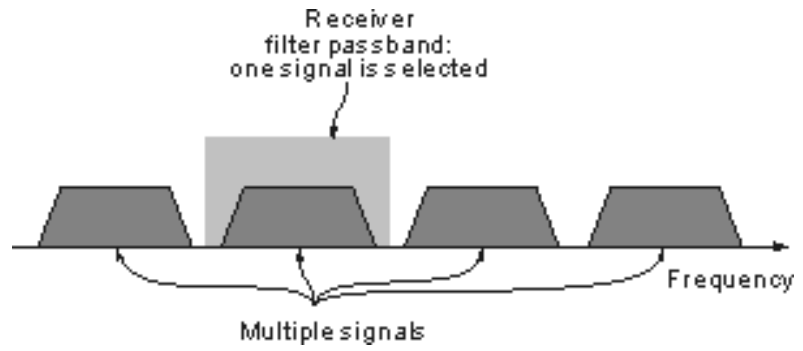
3.1–4.8 GHz



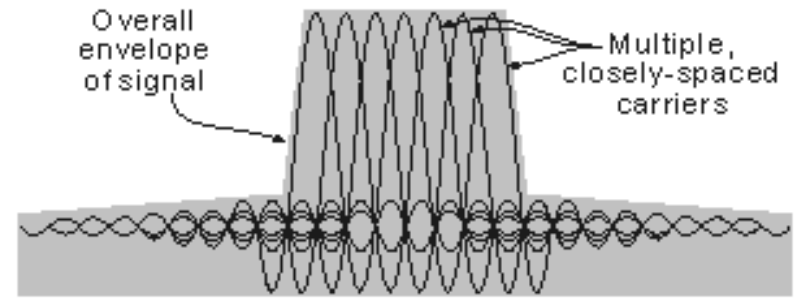
MB-OFDM UWB

3.1–10.6 GHz

Why using OFDM?



Traditional

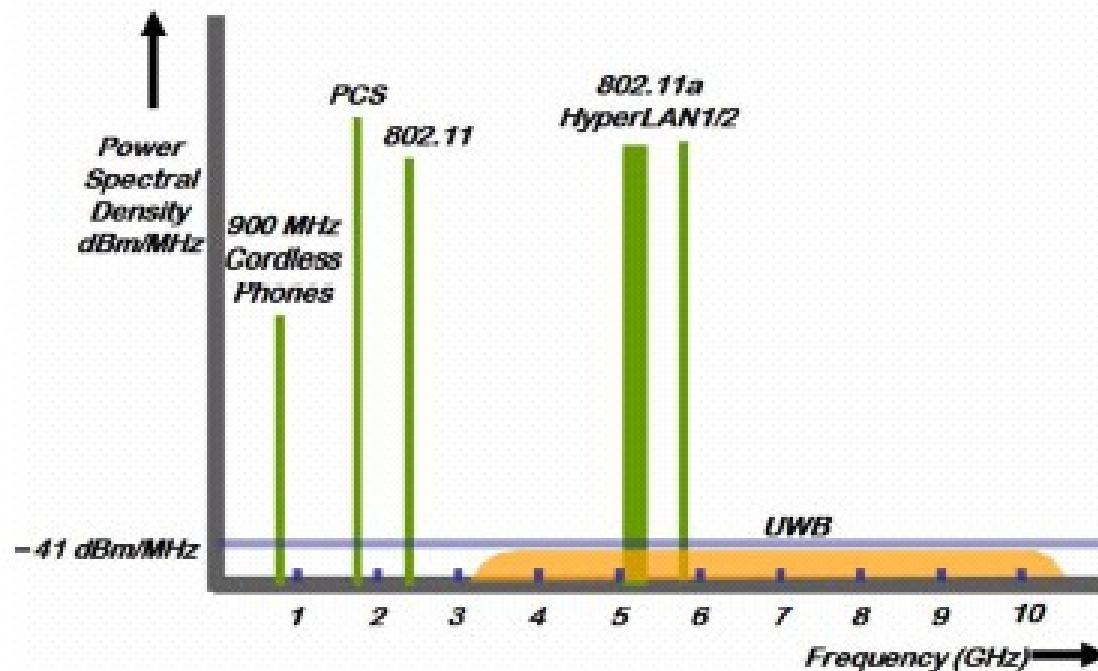


OFDM

- Subcarriers are orthogonal to each other
- In order to transmit an IFFT engine is necessary
- Therefore, a FFT engine (effectively an **spectrum analyzer**) is used at the receiver
- Possibility of spectrum shaping by **tone nulling**

Cognitive radio

Cognitive radio is a paradigm for opportunistic access of licensed (primary) parts of the electromagnetic spectrum by unlicensed (secondary) users.

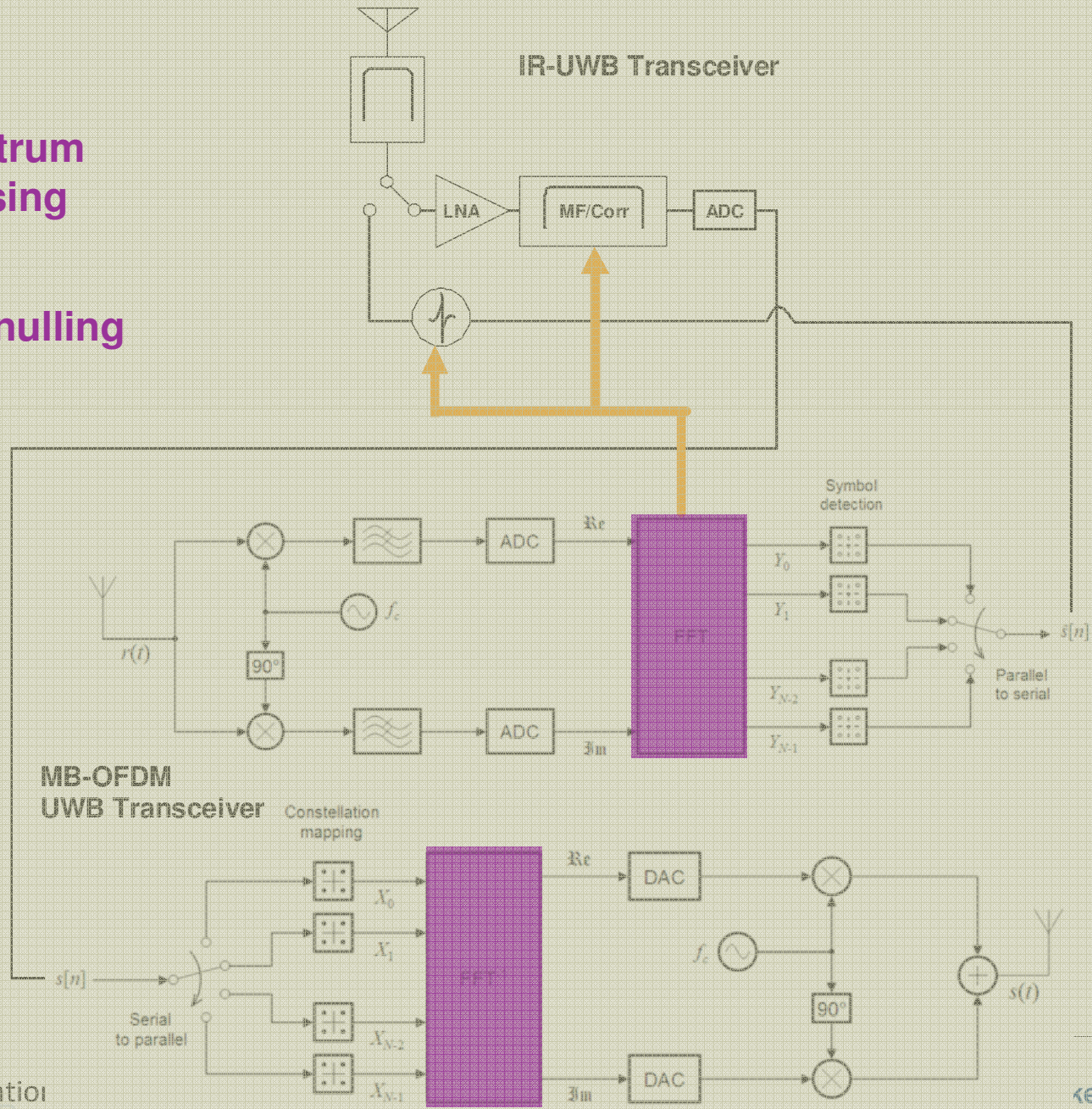


Where CR shall be implemented?

- **IR-UWB sensors**
 - Negligible interference source
 - Vulnerable to interference from other systems
 - Limited processing capabilities
- **WBAN network controller (BNC)**
 - Significant interference source
 - Vulnerable to interference from other systems
 - Much more complex electronics

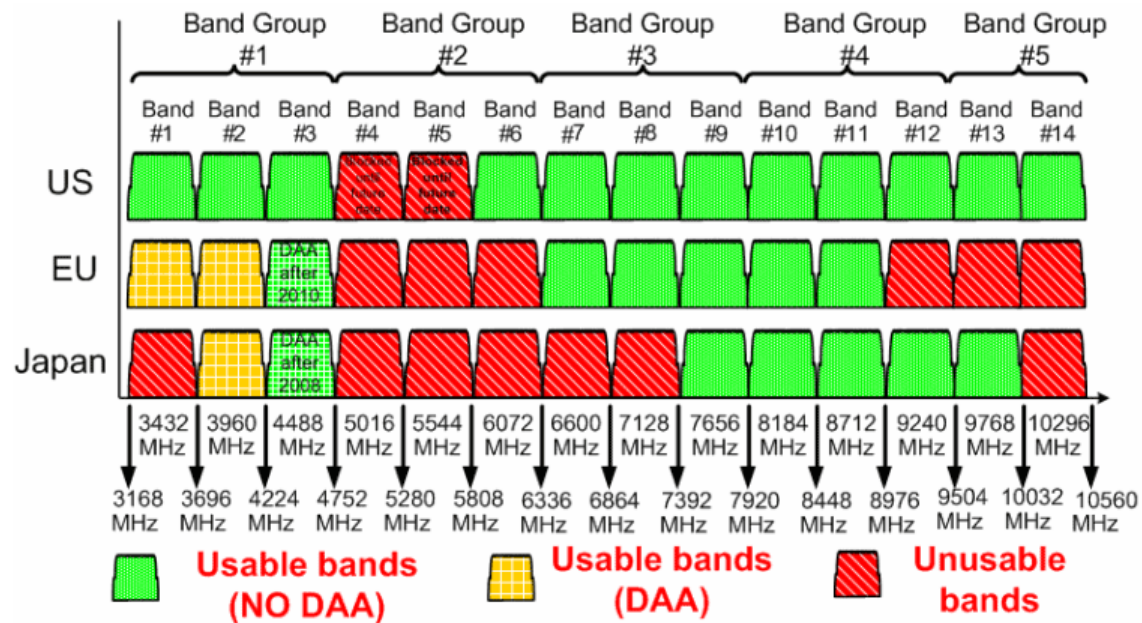
Spectrum sensing

Tone nulling



How a sensor should access the media (1)

- The subband division of EMCA-368 is adopted
 - 14 subbands of 528 MHz bandwidth
 - Subband 1,2, and 3 allocated to sensors



How a sensor should access the media (2)

- **The BNC broadcasts regularly information on spectrum availability**
 - Broadcast channel in any of subbands 1,2, or 3
 - Spectrum monitoring campaign necessary
- **IR-UWB transceivers tune matched filters and pulse generators**
 - Look-up table for simplicity
 - Only if high levels of interference are sensed the subbands is shifted
- **The BNC transmits in available subband**
 - Spectrum shaping by tone nulling when necessary
 - Susceptibility tests of medical equipment between 3.1–10.6 GHz
 - Localization system necessary

Future work on this topic

- Spectrum monitoring campaign of the 3.1–10.6 GHz band in hospital environments.
- Statistical characterization of the spectrum measurements.
- Design of a cognitive media access protocol.
- Implementation of a prototype on a SDR platform.

COLLABORATION SOUGHT!!!

Call For Papers

IEEE WIRELESS COMMUNICATIONS MAGAZINE
Special Issue on Cognitive Radio Networks: A Practical Perspective

Submission deadline: January 15, 2012

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Questions