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What is HBC?

BAN Communication Technology to transfer information through a human body

**Wireline Comm.**
- Heavy wiring
- Uncomfortable
- High S/N ratio
- High data rate

**Wireless Comm.**
- Heavy wireless equipment
- Uncomfortable
- Low efficient data transfer
- Errors in data transfer

**Human Body Comm.**
- Less expensive
- No wiring
- Small size
- Small power consumption
- High data rates
- High signal to noise ratio
HBC Application

- Build up Network among a lot of digital equipments (by mobile terminals)
  - Loaded in Mobile phone, TV, MP3 Player, Digital Camera, Notebook, Printer, Smart Home Network, Endoscope, ...
  - Support Ubiquitous Service by intuitive touching
Introduction

HBC Application

Touch and Play!!
Introduction

Why HBC?

- **Competition Service**
  - Bluetooth, ZigBee, UWB, NFC ...
  - Takes long times to setup a call
  - Power Consumption by using RF signaling

- **Requirements**
  - **Protocol**:
    - Context Aware Service, Intuitive Service, Quick Development
    - Expandability, Coexistence with Other Technology
    - Ad hoc Sensor Monitoring
  - **PHY**
    - Low Power Consumption for Mobile Equipment
    - Support High Data Rate
Challenge

Human Body as a Channel?

The First Try…

- Source: Multimedia Transmitter
- Connect IF Signal of Multimedia Transmitter to the Human Body
- Play the received Movie at Notebook
  - Data Rate: 2Mbps
  - BER: $4.7 \times 10^{-6}$ @ SNR = 16.7 dB
Human Body as a Channel?

The Second Try…

- Source: Mobile Phone to support DMB service

Prototype Hardware

BER $\leq 10^{-3}$ @
SNR $> 6$ dB
Characteristics of Signal and Noise

Noise
- Heavy amount noise in Low Frequency,
- Need to escape Low Frequency Band

Signal
- Emit Bigger power outside body as Frequency increase
- Body become antenna
- Need to specify the effective band
Characteristics of Walsh 64

Sub-group 0 (W_0~W_{19})

Sub-group 2 (W_{20}~W_{39})

Sub-group 1 (W_0~W_{29})

Sub-group 3 (W_{40}~W_{59})
Characteristics of Walsh 64

- Each Walsh Code has the major frequency components
- Select the 4\textsuperscript{th} sub-group of Walsh 64
FS-CDMA

- Method to transfer the baseband signal by using the characteristics of Walsh code
- S2P make 4bit symbols, then the symbols become the index of Walsh code
- FS-Spreader output the one code of the 4th sub-group
## Physical Parameter

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bandwidth</td>
<td>Frequency Selective Baseband (12 MHz ~ 16 MHz)</td>
</tr>
<tr>
<td>Comm. Env</td>
<td>Intra Body Communication</td>
</tr>
<tr>
<td>TX Method</td>
<td>Direct Digital Transmission</td>
</tr>
<tr>
<td>Duplex</td>
<td>TDD</td>
</tr>
<tr>
<td>Frame Length</td>
<td>10 ms</td>
</tr>
<tr>
<td>Preamble</td>
<td>$P(z) = z^6 + z^5 + 1$</td>
</tr>
<tr>
<td>Scrambling</td>
<td>32bit PRBS generator : $P(z) = z^{32} + z^{31} + z^{11} + 1$</td>
</tr>
<tr>
<td>Spreading</td>
<td>Frequency Selective 64 chip Walsh Modulation</td>
</tr>
<tr>
<td>Data Rate</td>
<td>2 Mbps ~ 250 Kbps</td>
</tr>
</tbody>
</table>
HBC System Review

Frame Structure

Frame (10 ms)

<table>
<thead>
<tr>
<th>DL Subframe</th>
<th>UL Subframe</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lock Time</strong></td>
<td><strong>Lock Time</strong></td>
</tr>
<tr>
<td><strong>Preamble 128 bits</strong></td>
<td><strong>Preamble 128 bits</strong></td>
</tr>
<tr>
<td><strong>Header 64 bits</strong></td>
<td><strong>Header 64 bits</strong></td>
</tr>
<tr>
<td><strong>Data Max. 16728 bits</strong></td>
<td><strong>Data Max. 3728 bits</strong></td>
</tr>
<tr>
<td><strong>CRC 16 bits</strong></td>
<td><strong>CRC 16 bits</strong></td>
</tr>
<tr>
<td>2us</td>
<td>4us</td>
</tr>
<tr>
<td>128us</td>
<td>7864us</td>
</tr>
<tr>
<td>2us</td>
<td>4us</td>
</tr>
<tr>
<td>128us</td>
<td>1864us</td>
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</tr>
<tr>
<td><strong>CRC 16 bits</strong></td>
</tr>
<tr>
<td>4us</td>
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<tr>
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HBC System Review

Demo of Video transmission

Player

Source
Currently Status

2Mbps FS–CDMA System
- Developed the Modules of HBC Controller
- Obtained BER of $10^{-6}$
- Verified some applications: transfer Video, transfer high quality Picture, transfer photograph from UMPC to Printer, ...
- Developed the chips of HBC Controller, being verified by some applications

10Mbps FS–CMDA System
- Developed the Modules of HBC Controller
- Being verified by some applications
What is Human Body Communication?
- BAN Communication Technology to transmit information through a human body
- Introduce some applications...

Human body as a channel?
- It is possible to transfer digital signals through a human body

HBC System Review
- Specify the effective Band
- Use Walsh Code to minimize interference → FS-CDMA

Currently Status of HBC System
- Developed The 2Mbps modules and chips
- Developed The 10Mbps modules
Thank you for your attentions!