Submission Title: [MICS Channel Characteristics, Preliminary Results]
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Abstract: [This document provides preliminary MICS band channel characteristics. The information is intended for the channel modeling subcommittee of the proposed IEEE 802.15.6 standard]

Purpose: [To present some preliminary data on MICS channel characteristics]

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MICS Channel Characteristics;
Preliminary Results

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Medical Implant Communication Service (MICS)

- Allocated frequency 402MHz to 405MHz
  - Total of 3 MHz spectrum

- Unlicensed band allocated for communication between an implanted medical device and an external controller

- Primary reasons for selecting these frequencies are
  - Better propagation characteristics for implants
  - Reasonable sized antenna for implants
  - Worldwide availability
  - Limited threat of interference to primary users
A 3D Immersive Platform to Study MICS Channel

As in-body measurement and experimental study is difficult (if not impossible), a 3D simulation & visualization scheme is proposed to study the propagation characteristics of MICS.
System Components

Human Body Model
- Dielectric properties of 300+ parts in a male human body
- Frequency-dependent biological material
- Properties are user-definable if changes are desired
- Accuracy of 2mm

Propagation Engine
- 3D full-wave electromagnetic field simulation (HFSS)
- Capable of calculating a variety of outputs

3D Immersive & Visualization Platform
The NIST 3D Immersive Platform

The 3D immersive & visualization platform is a system to present the user a 3D virtual world within which the user can move and interact with the virtual objects.

☑ Provides views and interaction for a qualitative experience of data
☑ Main components of the system are:
  ❖ Three screens that provide the visual display; a single 3D stereo scene
  ❖ The motion tracked stereoscope glasses; to update the scene based on the motion of the user
  ❖ Handheld motion tracked input device to allow interaction with the virtual object(s)

A User in the NIST Immersive Visualization Environment
Input Parameters

- Antenna characteristics
- Antenna Location
  - Pacemaker application
- Antenna Orientation
  - Facing toward front side of the body
- Operating Frequency
  - 403.5 MHz
- Transmit Power
- Resolution
  - 2 mm
- Range
  - 50 cm
- Output Parameter
  - Electric field magnitude
  - Magnetic field magnitude
  - SAR
Antenna

- Size: 8.2 x 8.1 x 1 mm
- Metallic Layer: Copper, \( t = 0.036 \) mm
- Substrate: D51 (NTK), \( \varepsilon_r = 30, \tan \theta = 0.000038 \), and \( t = 1 \) mm
- The metallic layer is covered by RH-5, \( \varepsilon_r = 1.0006 \), \( \tan \theta = 0 \), \( t = 1 \) mm
Return Loss of the Antenna
Electric Field Magnitude Along Four Directions

- Antenna is located at the left Pectoral muscle
- Frequency is 403.5 MHz
- We have measured the Magnitude of the E-Field & H-Field along four directions as shown here
Electric Field Magnitude Along the Front-side

![Graph showing the electric field magnitude along the front-side range (mm). The x-axis represents the range (mm) from 0 to 500, and the y-axis represents $20 \log_{10}(E_{magnitude})$. The graph includes a red arrow indicating the Body surface.]
Electric Field Magnitude Along the Backside

![Graph showing electric field magnitude along the backside with range (mm) on the x-axis and 20*log10(E magnitude) on the y-axis, with a peak at the body surface.]
Electric Field Magnitude Along the Left-side

(range (mm))

20*\text{log}_{10}(E \text{ magnitude})

Body surface
Electric Field Magnitude Along the Right-side

![Graph showing the electric field magnitude along the right-side with a logarithmic scale. The graph plots 20*log10(E magnitude) against range (mm). The body surface is indicated.]
Magnetic Field Magnitude in the 4 Directions

- **Front**
- **Back**
- **Left**
- **Right**
Horizontal Radiation Pattern
Vertical Radiation Pattern
Issues to be considered

- What frequency should be considered for implant to implant channel model?

- Are there currently any application for implant to implant communication so that we can simulate the right scenarios?

- Will there be any measurement for S6 (S7) with MICS frequency band?
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