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Abstract: [Discussions on Antenna, Wave Propagations, and Field Regions for Body Area Network]

Purpose: [To provide an introduction on Antenna, Wave Propagations, and Field Regions for Body Area Network]

Antenna, Wave Propagations, and Field Regions for Body Area Network

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The BAN Antenna and Wave Propagation

- The antenna performance is affected by the material which an antenna is attached on it
- We can not design the BAN wireless device without investigating the electromagnetic properties of the body.
- The E & H-fields inside a dielectric tissue depend both on the depth and on the exact composition of the body.
- The exact field that an antenna operates will depend on the thickness of the skin, fat and muscle layers, which varies between individuals and with time.

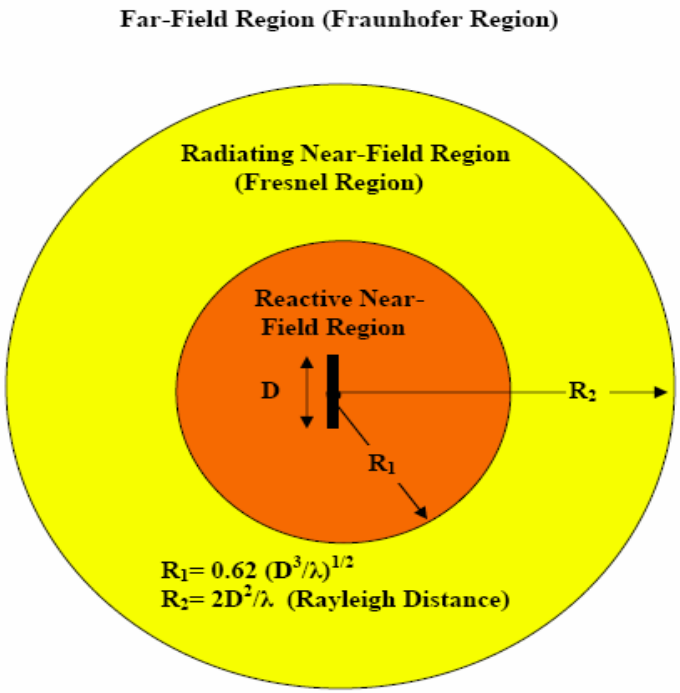
Difficulty to Calculate an Antenna Parameters

1. The wavelength in the tissues is shorter, since the wave propagation speed is lowered.
2. The losses in the tissues will affect both the near-field and the wave propagation.
3. The efficiency of an antenna is not obvious, as the far-field is attenuated to zero due to the losses.
4. The electromagnetic field from small antenna can be expressed in terms of currents in the antenna.

Electromagnetic Field and Electromagnetic Wave

- The area from the antenna to the point where the electromagnetic field forms ($R<\lambda/2\pi$) is called the near-field of the antenna.
- The area after the point ($R>\lambda/2\pi$) at which the electromagnetic field begins to separate from the antenna and wanders into space in the form of an electromagnetic wave is called the far-field.
- The near-field coupling is proportional to radiating element surface area, but the far-field transmission efficiency is maximized by matching the impedance of the radiating elements to free space.

Field Regions Around an Antenna



Reactive Near-Field	$R < 0.62 (D^3/\lambda)^{1/2}$
Radiating Near-Field	R1<R<R2
Far-Field	$R > 2D^2/\lambda$

When an electromagnetic wave is launched from an antenna, the area around the antenna can be divided into different regions: the reactive near-field region, the radiating near field region and the far field region. Sometimes another zone is also defined, described as the transition zone or region between the radiating near field and the far field region.

Near Field

- In region close to source, the field is called near field
- In the near field the E and H fields are not necessarily perpendicular
- It is not always conveniently characterized by wave
- It is often more non-propagating in nature and is therefore called induction field
- The near field vary rapidly with space
- The mathematical expressions for near field contain the terms $1/r$, $1/r^2$, $1/r^3$,…, where r is the distance from the source to the field point.
- Objects placed near source may strongly affect the nature of the near field

Conclusion

- Care must be taken when the terms of Near and Far -fields are used for the BAN applications.
- The differences in the wave propagation velocity for the implanted device and free space should be taken into account.
- The near-field coupling is proportional to radiating element surface area.
- The radiating element size is important for near field communication.
- The far-field transmission efficiency is maximized by matching the impedance of the radiating elements to free space.