

A close-up photograph of a breadboard circuit. The breadboard is white with a grid of holes. Various electronic components are connected: several resistors with color-coded bands, thin metal wires, and thicker colored wires (blue, yellow, black, white). A black integrated circuit (IC) is visible in the lower-left foreground. The background is slightly blurred, showing more of the breadboard and other components.

*Wireless communication
and power transfer for
implantable medical devices*

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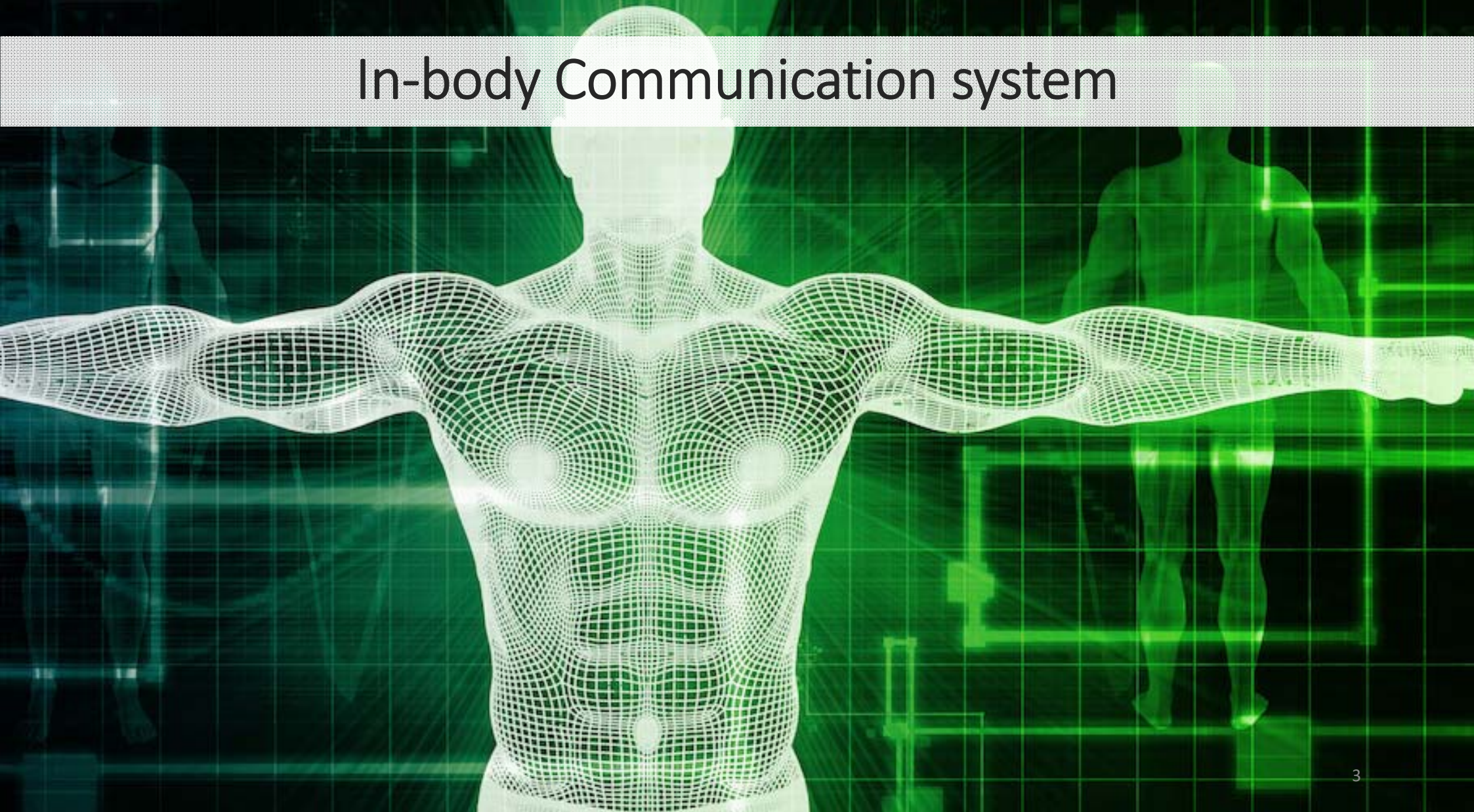
Contents

Wireless communication

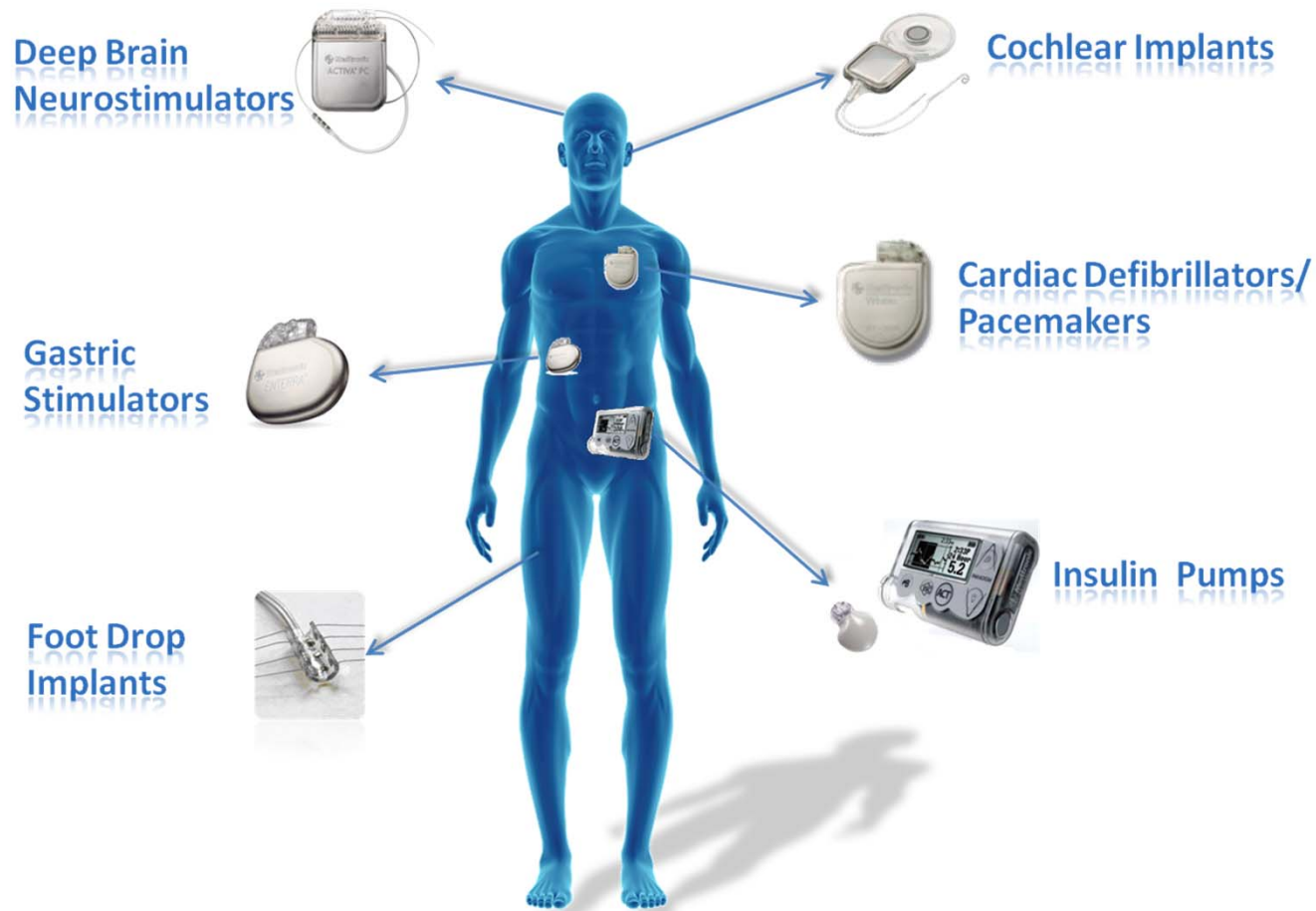
Wireless power transfer

Joint wireless communication and power transfer

In-body Communication system



Wireless Implantable Medical Devices



In-body Communication methods



Radio Frequency
Communication



Inductive
coupling



Human Body
Communication



Ultrasound
Communication

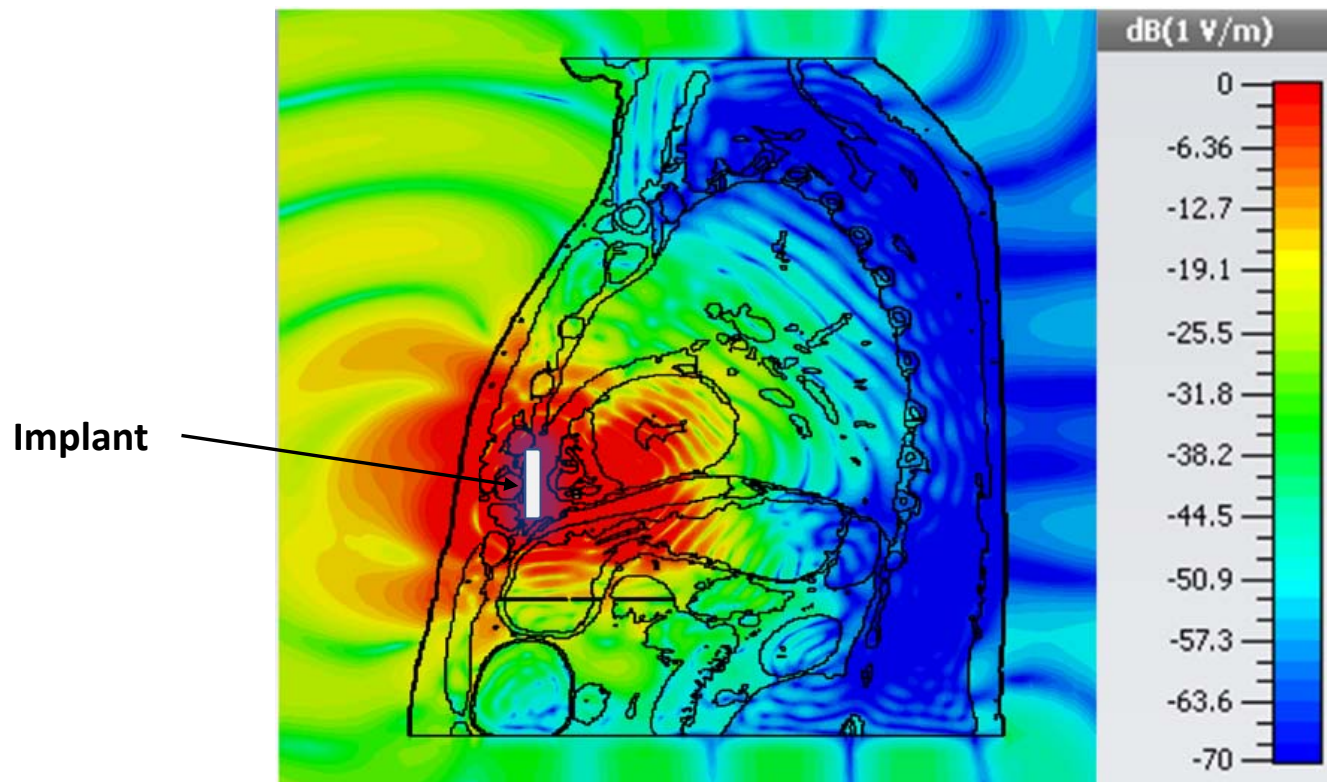


Optical
Communication



Molecular
Communication

Radio Frequency Communication



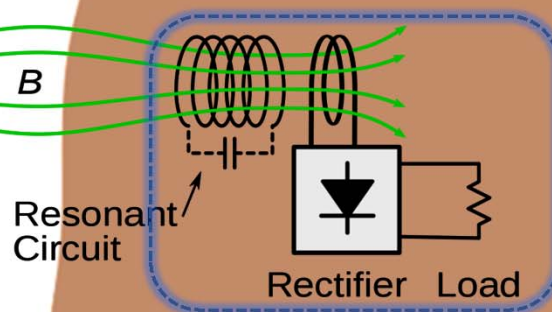
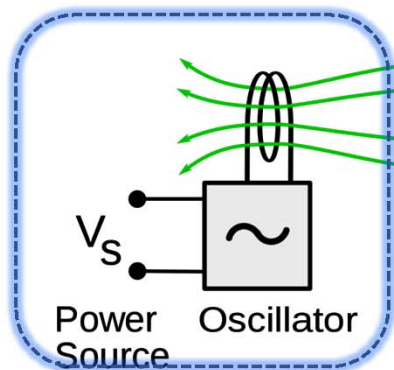
- deep implants
- Standards available



- Parameters depend on frequency
- High power consumption

Inductive coupling

External power source



In-body implant



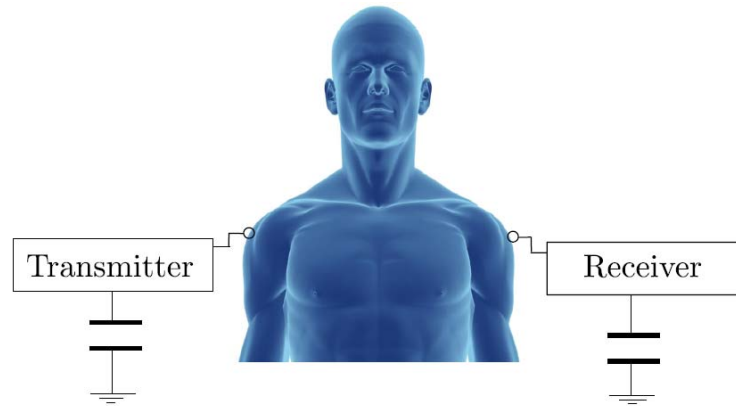
- Simple architecture
- Can be used for power transfer



- Small bandwidth
- Short range

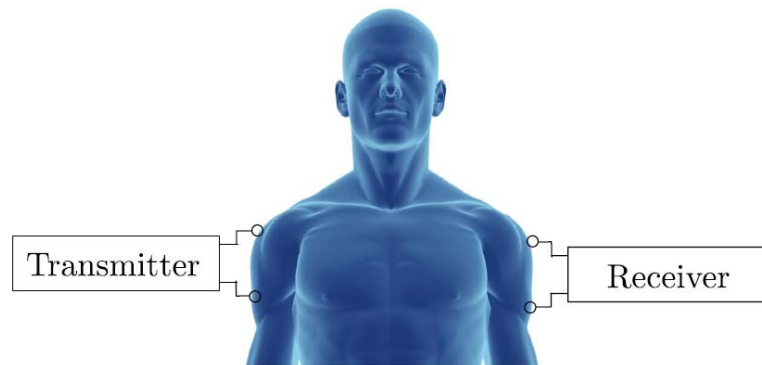
Human Body Communication

Capacitive coupling



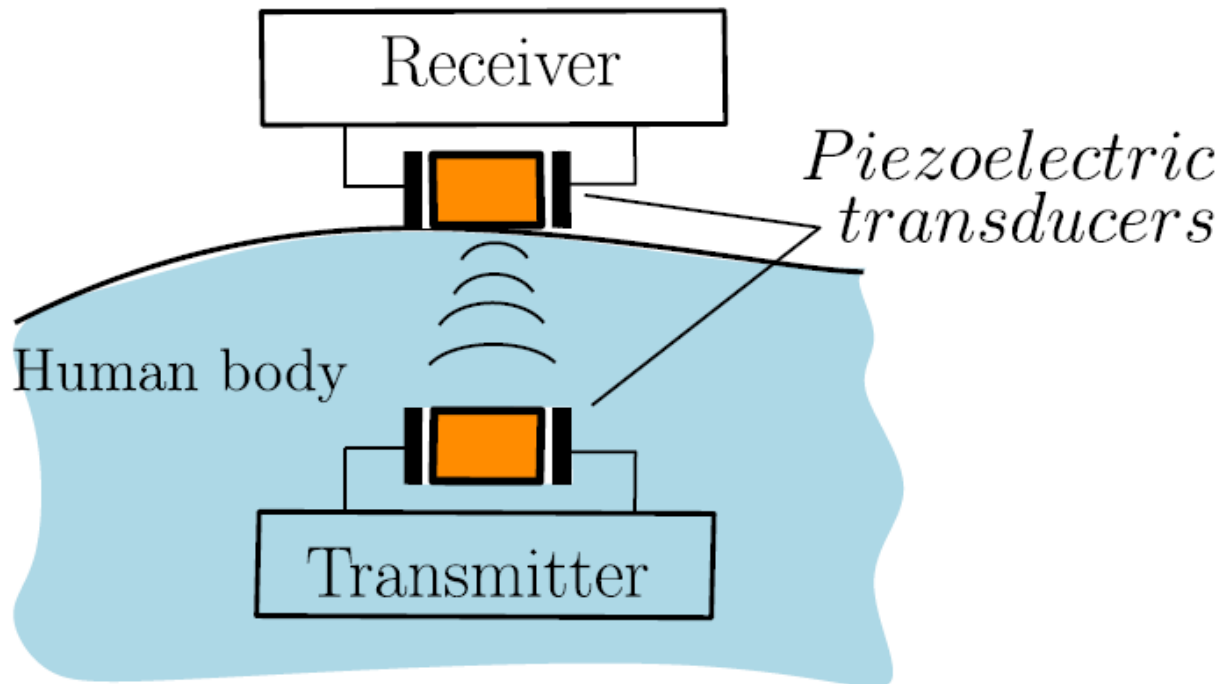
- Low power
- Very small size

Galvanic coupling



- Results vary based on tissue layer
- Short range

Ultrasound Communication

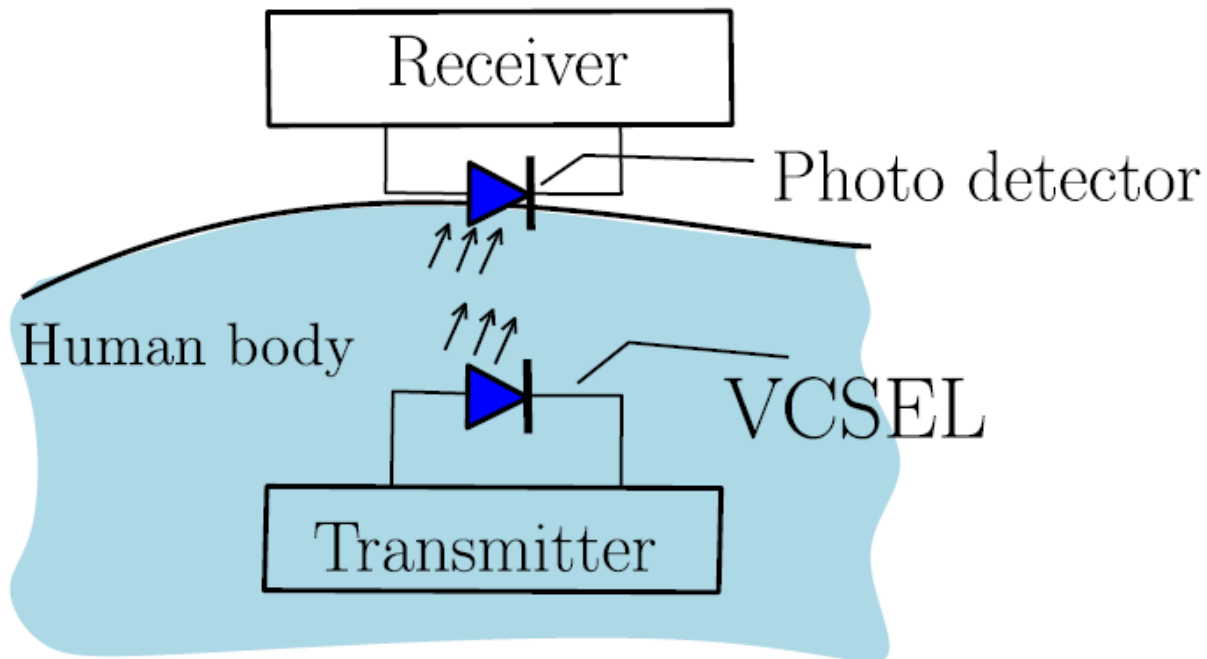


- Low attenuation
- Low power



- Reflected by bones
- Low data rate

Optical Communication

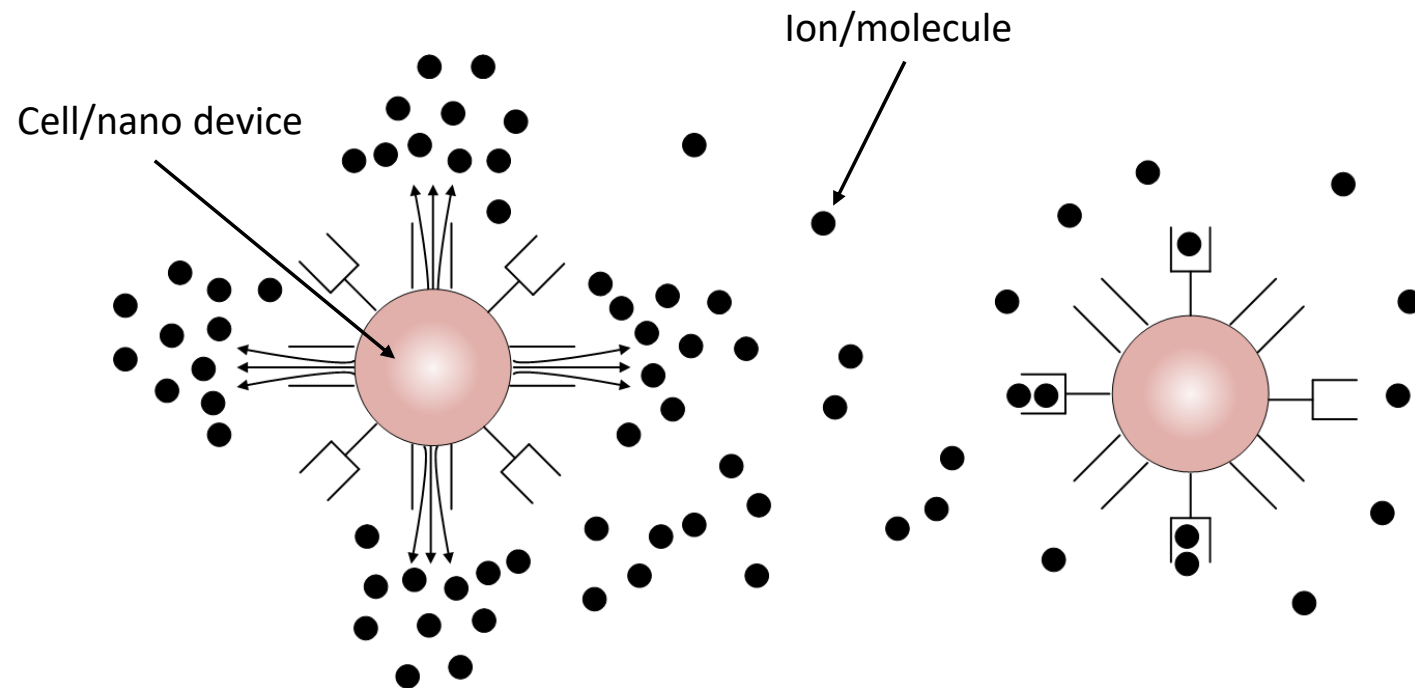


- Very high data rate
- Ultra small implants



- Very high absorption by skin
- Only mm range

Molecular Communication

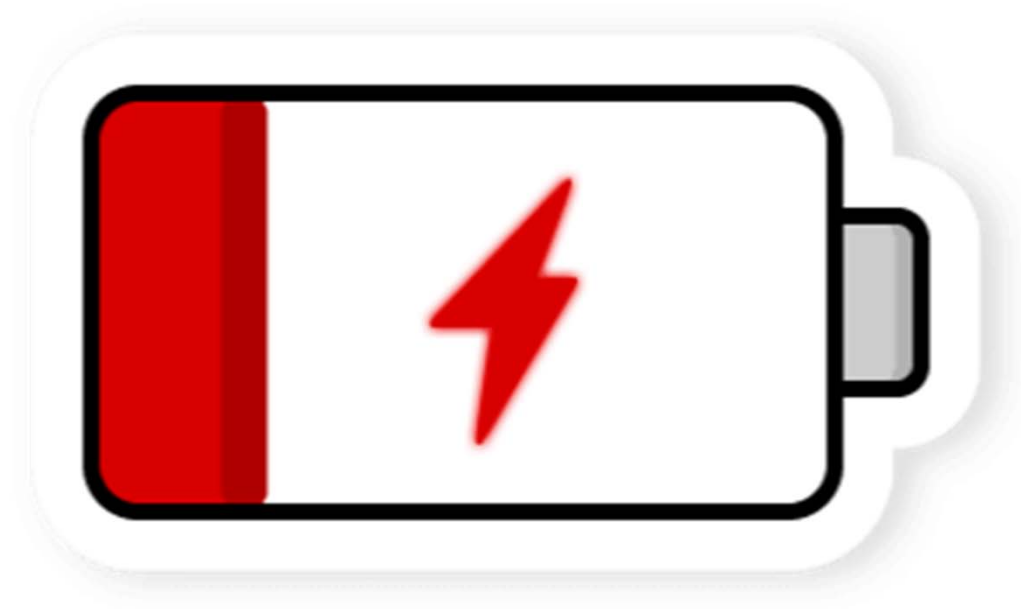


- Biocompatible
- Negligible power consumption



- Limited research till now
- Not much practical implementation

Longevity ???



Wireless Energy Transfer Examples

Inductive Coupling



The Qi wireless mobile device charging Standard



Electric tooth brush



Wireless powered medical implants

Magnetic Resonant Coupling



Qualcomm eZone wireless charging



Qualcomm Halo electric vehicle powered by charging pad



Haier wireless powered HDTV

EM Radiation



Intel WISP RFID tags harvest energy from RF radiation



Powercast RF harvesting circuit for sensor networks



The SHARP unmanned plane receives energy beamed from the ground

Microwave Enabled Wireless Energy Transfer

Nikola Tesla (1856-1943)



- ❑ In the very early days of electricity before the electric grid was deployed, Tesla was very interested in developing a scheme to transmit electricity wirelessly over long distances.



- ❑ It ran into some financial troubles and that work was never completed

RF based Wireless Power Transfer

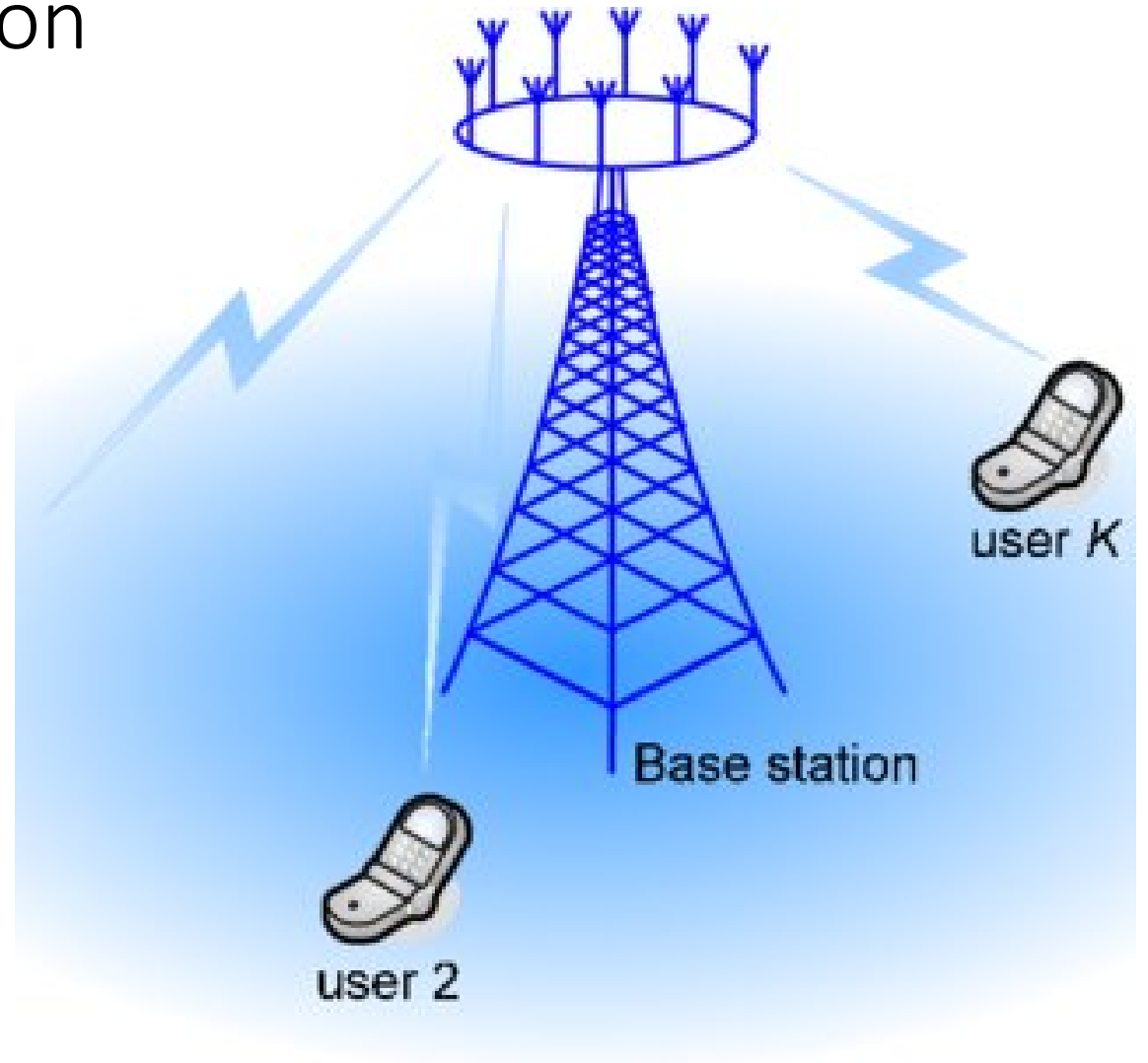
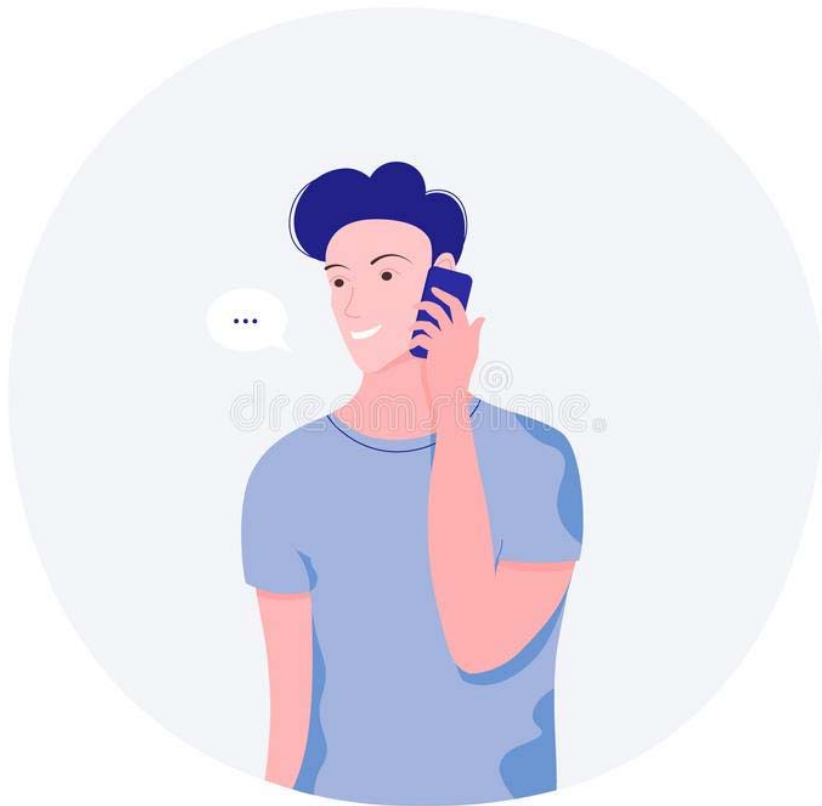
- **Key benefits**

- **Power over distance:** 
- **One-to-many** 
- **Power is controllable**
 - RF power level
 - Transmit Frequency/Antenna/Number of transmitters
 - Distance, cots, etc.
- **Abundant application in WSNs: building automation, structural monitoring, defense, data centers, smart grid,...**

- **Limitations**

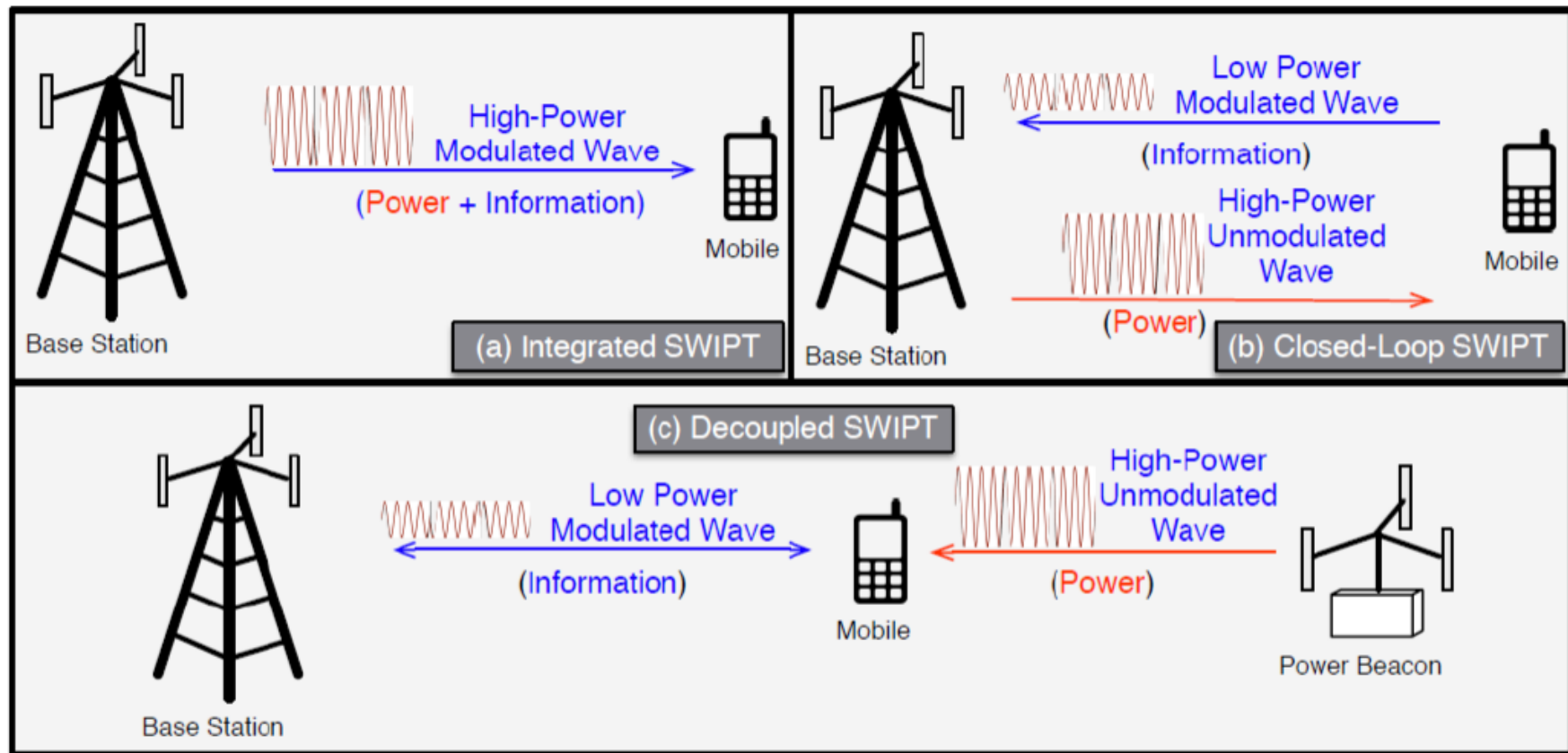
- **Low received power (e.g., smaller than 1uW* at distance >5m, transmit power <1W)**

Cellular Communication

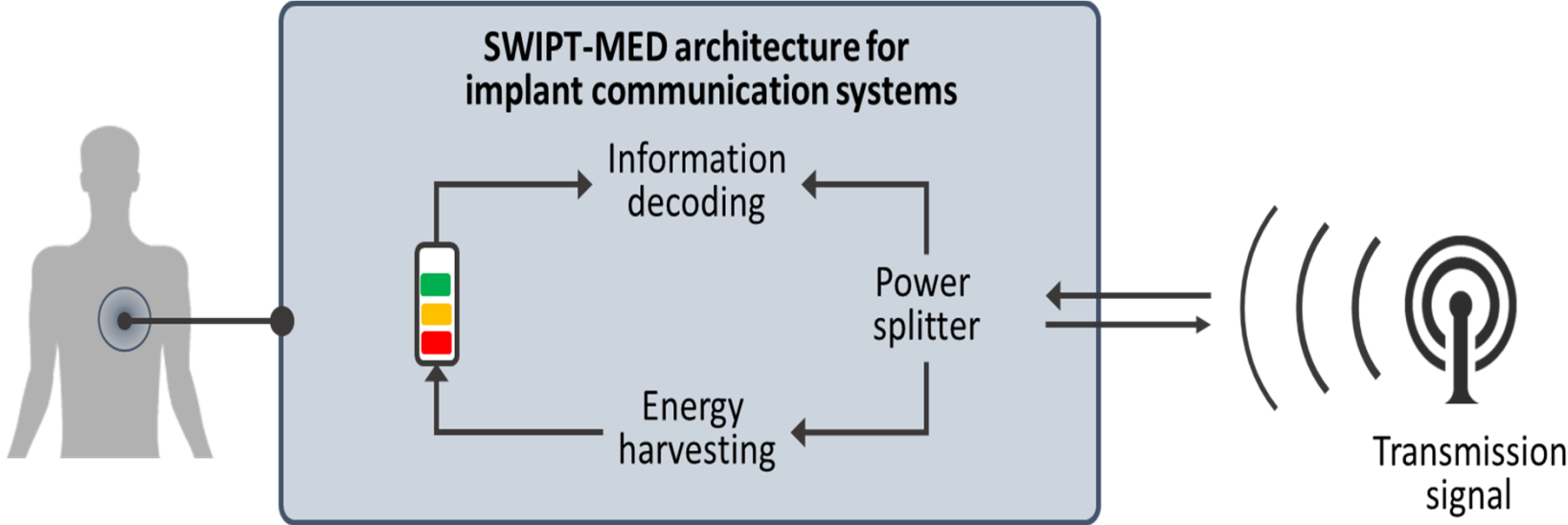


Simultaneous Wireless Information and Power Transfer (SWIPT)

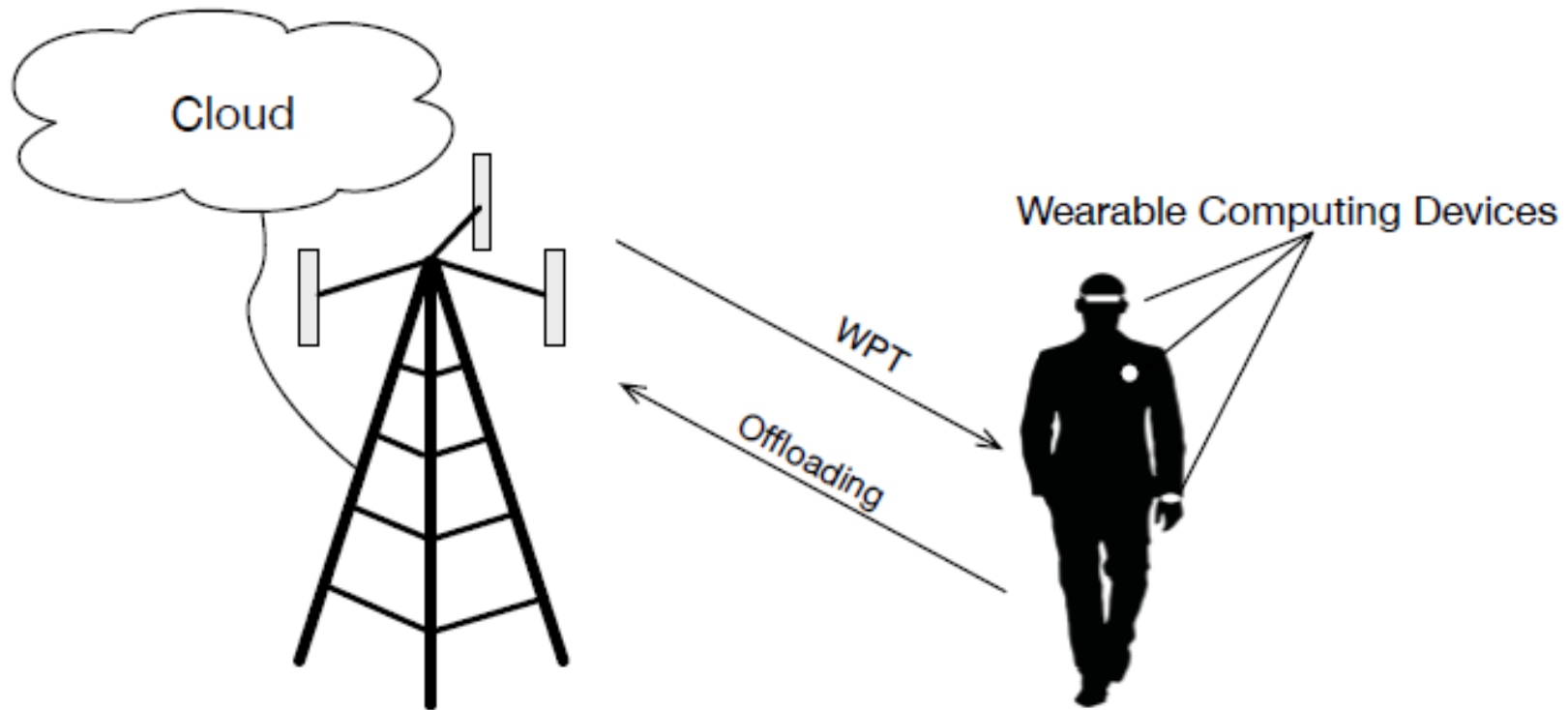
By means of appropriate signal processing, **both information and energy** can be transmitted to receivers of any kind, **simultaneously**.



Simultaneous Wireless Information and Power Transfer for Medical Implants



Wireless powered system



Thank you !!!