CSE311 Microwave Engineering

LEC (02) – Chapter (02)
Microwave Systems

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LECTURE OUTLINES

MICROWAVE SYSTEMS

1- MOBILE PHONE SYSTEM

2- MOBILE JAMMING

3 – SIGNAL ENHANCER

4 – GPS & GSM MODULES

5 – RF TRANSCEIVERS

6 – RFID SYSTEMS

7 - GPR

8 – AUTOMOTIVE RADAR

9 – ENERGY HARVESTING SYSTEM

10 –NETWORK ANALYZER / FREQ. SPECTRUM

11 – MW IMAGING

12 – HIGH POWER MW SYSTEMS

1- MOBILE PHONE SYSTEM

RADIO TRANSMISSION MODES

1 – **Simplex Mode** (one way transmission)

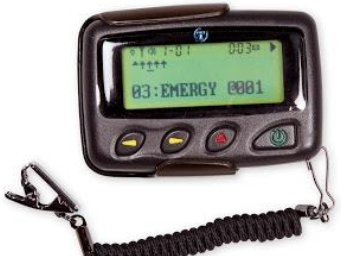
Ex:) pager

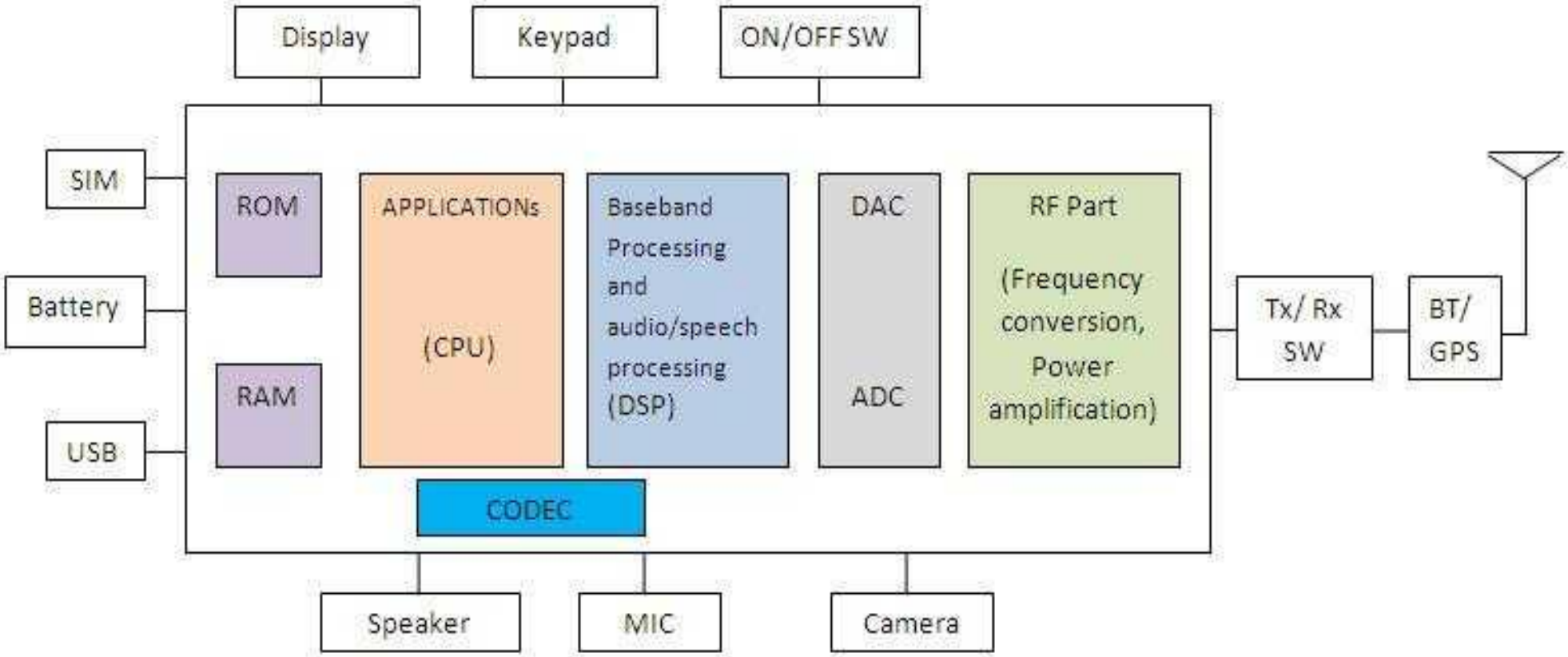
2- **half duplex** (transmit & wait for receiver)

Ex:) police phones / walky-talky

3 – **full duplex** (transmit & receive at the same time)

EX:) phones / Mobiles




Display
Keypad
ON/OFF SW
SIM
Battery
USB
ROM
RAM
APPLICATIONs
(CPU)
Baseband
Processing
and
audio/speech
processing
(DSP)
DAC
ADC
RF Part
(Frequency
conversion,
Power
amplification)
Tx/ Rx
SW
BT/
GPS
CODEC
Speaker
MIC
Camera

Radio Frequency Processing Section

The RF section is the part of the cell-phone circuit is also known as **RF Transceiver**.

It is the section that transmits and receives certain frequencies to a network and synchronizes the same to another phone.

The RF - A radio section is based on two main Circuits:

1 Transmitter

A Transmitter is a circuit or device which is used to transmit radio signals in the air.

2 Receiver

A receiver is simply like radios which are used to receive transmissions (Radiation) which is spread in the air by any transmitter on a specific frequency.

Analog Baseband Processor

A/D and D/A section

This section converts and processes the analog to digital (A/D) signals and digital to analog (D/A) signals.

Control section

This is the section which acts as the controller of the input and output of any analog and digital signal.

Power Management

A power management section in mobile phones is designed to handle energy consumed in mobile phones. There are two main sub sections in a single power section.

- **Power Distribution and switching section**

A power distribution section is designed to distribute desired Voltages and currents to the other sections of a phone. This section takes power from a battery (which is figured commonly at 3.7 Volts).

Analog Baseband Processor (Cont.)

- **Charging Section**

The Charging section is based on a charging IC which takes power from an external source and gives it to the battery to power it up again when it is exhausted. This section uses the charge from external battery charger, and regulates it to a suitable value for the battery. The battery is charged by this process and it is ready to use for the next session (a battery session is a time which is provided by the manufacturer of a cell phone for standby or talk time.)

Audio Codecs Section

This section is where analog and digital audio properties are processed - like the microphone, speaker, headset, ring-tones, and also the vibrator circuits.

Digital Baseband Processor

Digital Baseband Processor section is used in mobile phones to handle data input and output signal like switching, driving application commands, and memory accessing and executing.

This part consists of :

CPU(Central Processing Unit)

The Central Processing Unit (CPU) is responsible for interpreting and executing most of the commands from the user interface. It is often called the "brain" of the microprocessor, or the central processor.

Flash and Memory Storage Circuits

*RAM(Random Access Memory)
*ROM, Flash(Read Only Memory)

Interfaces such as the following are also part of this section:

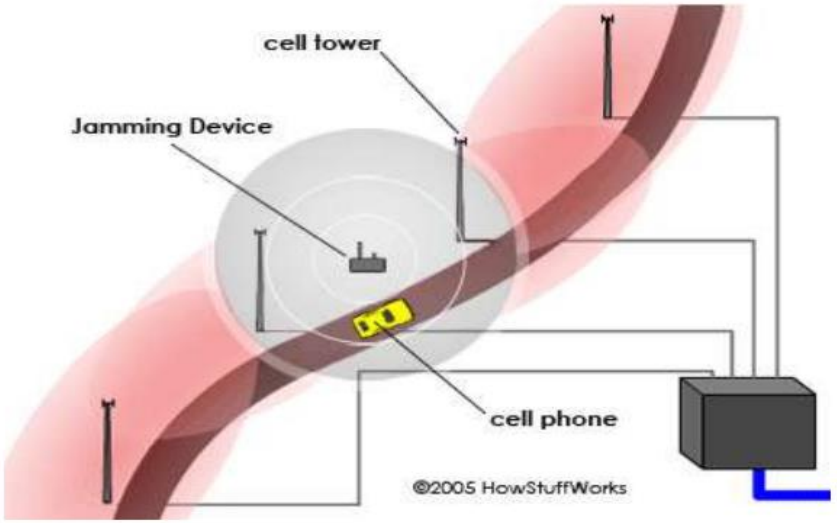
*Bluetooth *Wi-Fi *Camera *Screen Display *Keypads *USB *SIM-Card

2- MOBILE JAMMING/SILENCE

- It is a device that transmit signal on the same frequency at which the GSM system operates, the jamming success when the mobile phones in the area where the jammer is located are disabled.
- A jamming device transmits - same radio frequencies of greater power as the cell phone, disrupting (disable) the communication between the phone and the cell-phone base station in the tower. It's a called a denial-of service (service down) attack. This causes interference with communication of cell phones and towers to render the phones unusable. On most phones, the network would be out of range.
- So Jammers work by either

  Disrupting phone to tower freq.

  or tower to phone frequencies.



There are different types of mobile phone jammer.

- ❑ Low power
- ❑ Medium power
- ❑ High power
  - ➔ A low power jammer will have a small range
  - ➔ a high power jammer will have a larger range

- ✓ It all depends upon whether you want to do jamming only in a small room or in a big hall
- ✓ military convey they actually do a jamming for several hundreds of meter ranges.
- ✓ jammers can be single band or multi band using antennas can be two type omnidirectional antenna which has a radiation pattern which radiates in this particular direction equally, but not in the vertical direction radiation.

Applications of Mobile Jammer

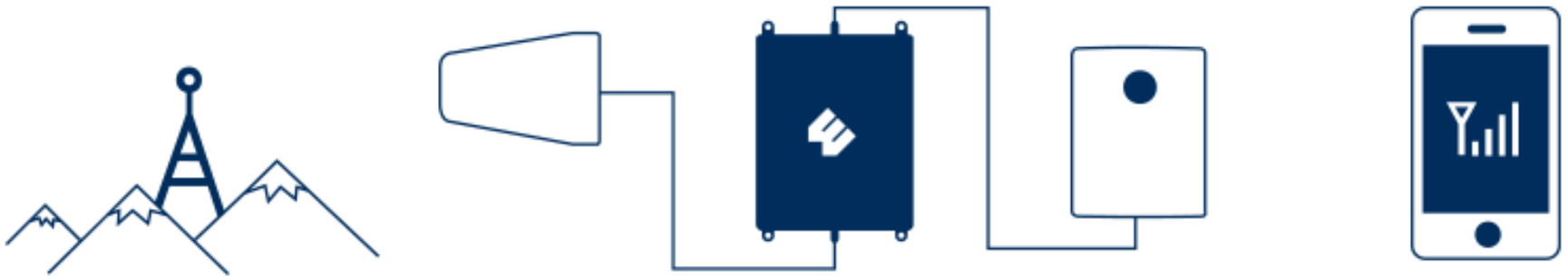
- To maintain the complete silence in library and lecture hall
- To avoid fraud in examination hall
- To avoid disturbance in class room
- For providing security in business conference, board of directors rooms, seminars, etc.,
- For providing calm and peaceful atmosphere in Hospitals
- Mosques/ Church

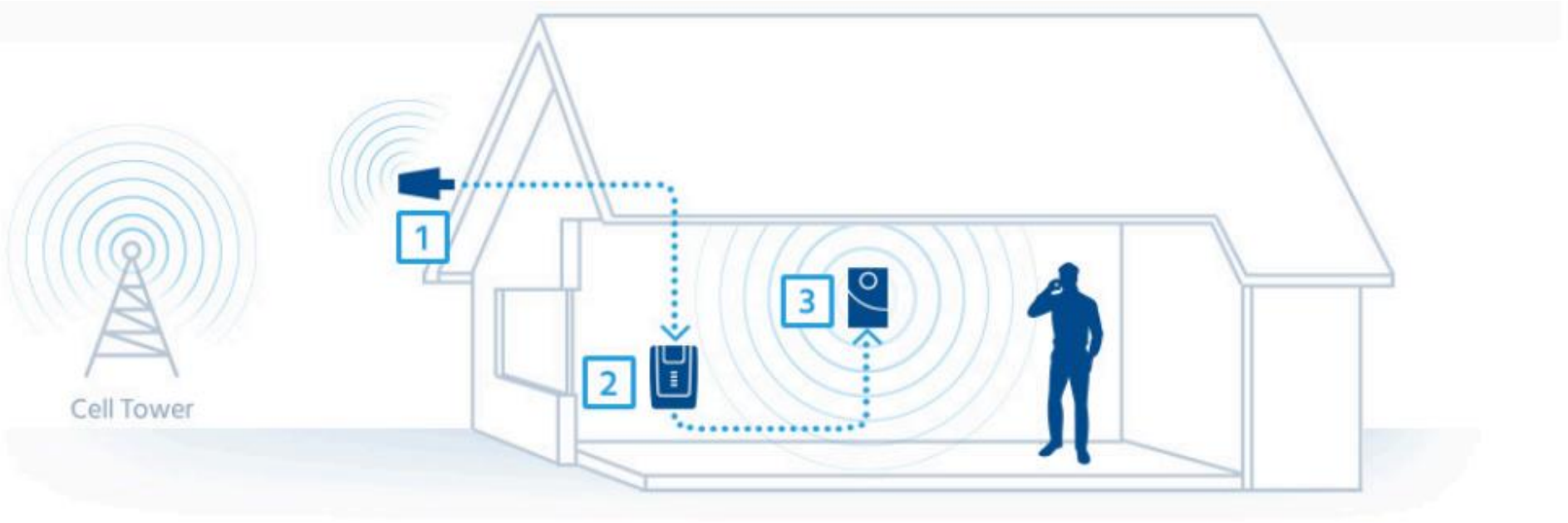
Design Parameters/Specification

- The frequency bands
- Distance to be jammed (D)
- **Free space loss**
- Power calculations

3 – SIGNAL ENHANCER / REPEATER / BOOSTER

How it works?



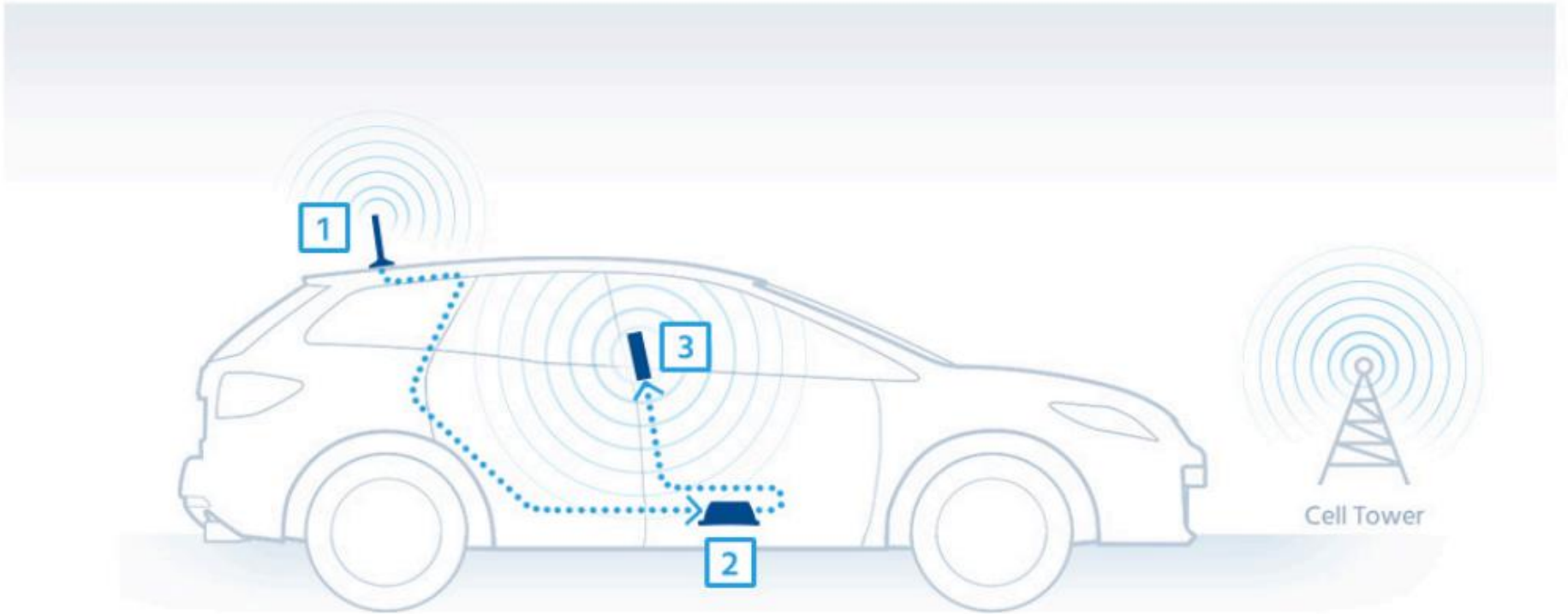


1 **Outside Antenna**
Pulls in Tower Signal

2 **Signal Booster**
Amplifies the Signal

3 **Inside Antenna**
Re-broadcasts Signal

Cell Phone
Gets Boosted Signal



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GSM booster

Bluetooth booster

Wi-Fi booster

4 – GPS & GSM MODULES

GPS and GSM Modules

Global Positioning System (GPS) receiver module gives the location of the carrier and time and tracks GPS satellites using circularly polarized antenna at 1575 MHz.

GPS Data can be stored in a memory and retrieved later.

Data can be transmitted using GSM module at a predefined interval or on demand.

Data can be transmitted using transceiver

APPLICATIONS

Vehicle Tracking, Remote Monitoring, Location Identification, People Tracking, etc.

SIM 808

SIM 900

In real , GPRS modules OK outdoor , not perfect indoor

5 – RF TRANSCEIVERS

RF Transceivers

RF Transmitter, Receiver and Transceiver

Data can be transmitted using specified frequency by WPC (Wireless Planning Commission)

- 433 MHz, 866 MHz, 2.45 GHz, 5.8 GHz
- Data Rate, Bandwidth

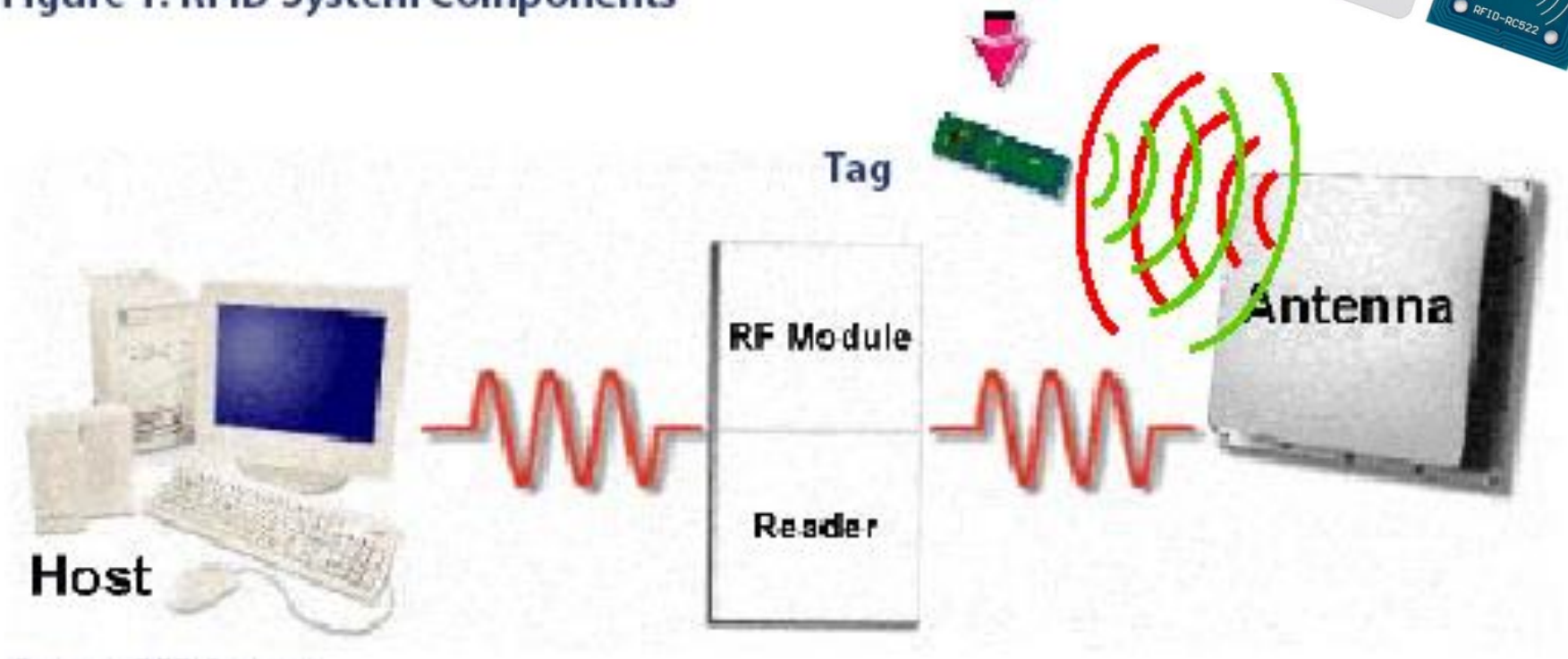
Application environment

automobile anti-theft products
home security products
electric doors, shutter doors, windows
remote control LED / audio / electric doors, garage /electric cars / MP3.

6 – RFID SYSTEMS

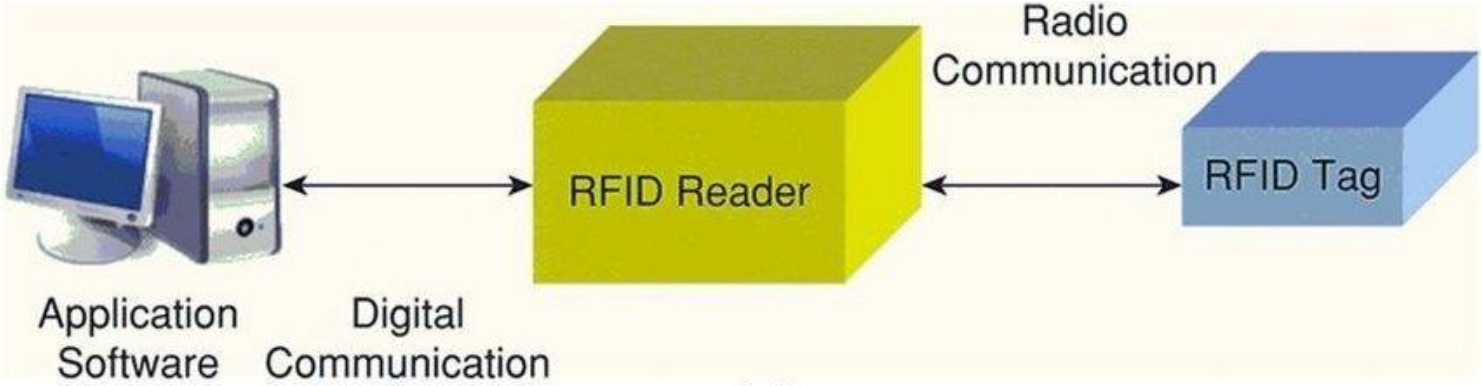
RFID System Architecture

Figure 1: RFID System Components

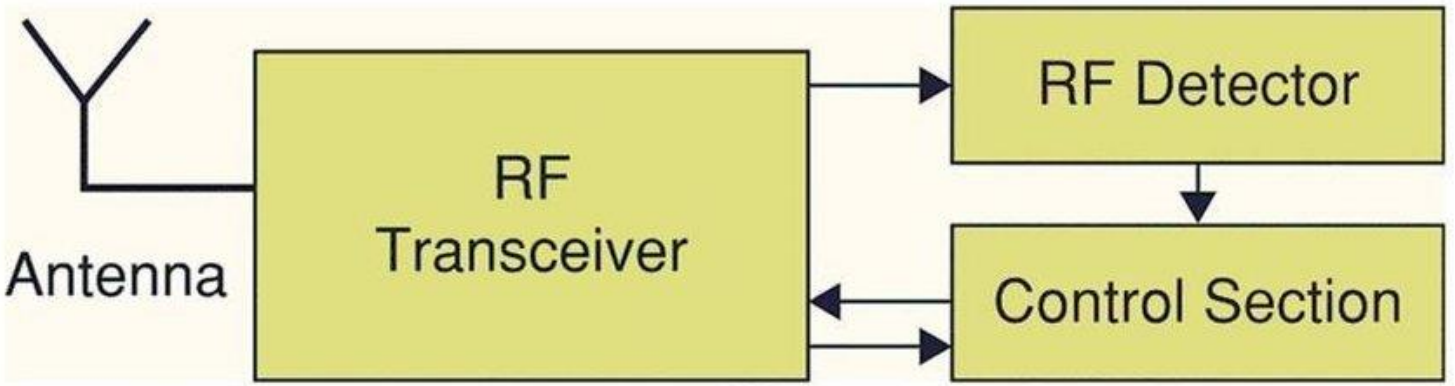


Source: QED Systems

RFID System Architecture



(a)



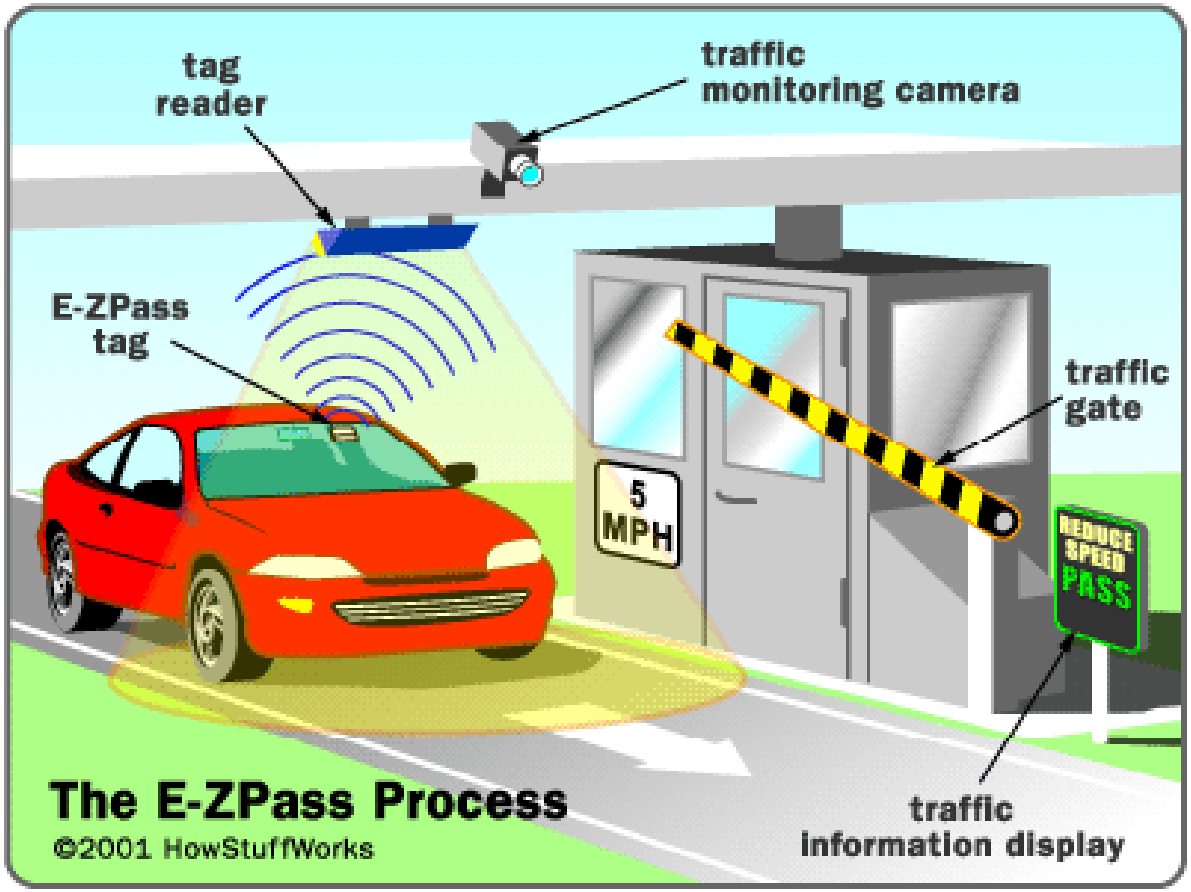
(b)

- RFID systems may use a particular frequency band depending on:
  - Application // Legislature // Cost considerations

Frequency Band	Characteristics	Typical Applications
Low 100-500 kHz	Short to medium read range, inexpensive, low reading speed	Access control Animal/Human identification Inventory Control
Medium 10-15 MHz	Short to medium read range Potentially inexpensive Medium reading speed	Smart Cards
High UHF: 850-950MHz Microwave: 2.4 – 5.8 GHz	Long read range High reading speed Line of sight required (Microwave) Expensive	Railroad / car monitoring Toll collection systems (OGS)

Applications

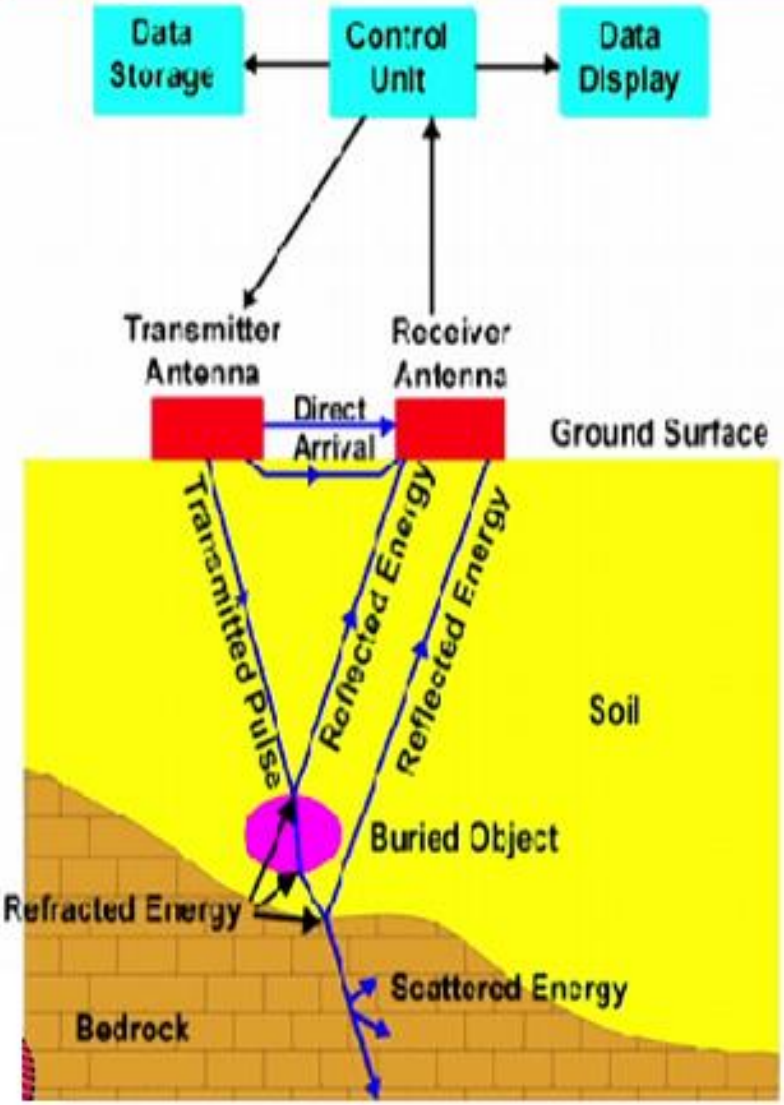
Automated Toll Collection



Applications

7 - GPR

Ground Penetrating Radar (GPR)



GPR is used for buried objects, landmine detection.

Reflected amplitude & phase data are captured for reconstruction of images for underground objects.

Depth of penetration depends on transmitted power and frequency.


LMX200
POLICE
CAT

8 – AUTOMOTIVE RADAR

Radar Systems for Automobiles

10 GHz / 24 GHz Radar System

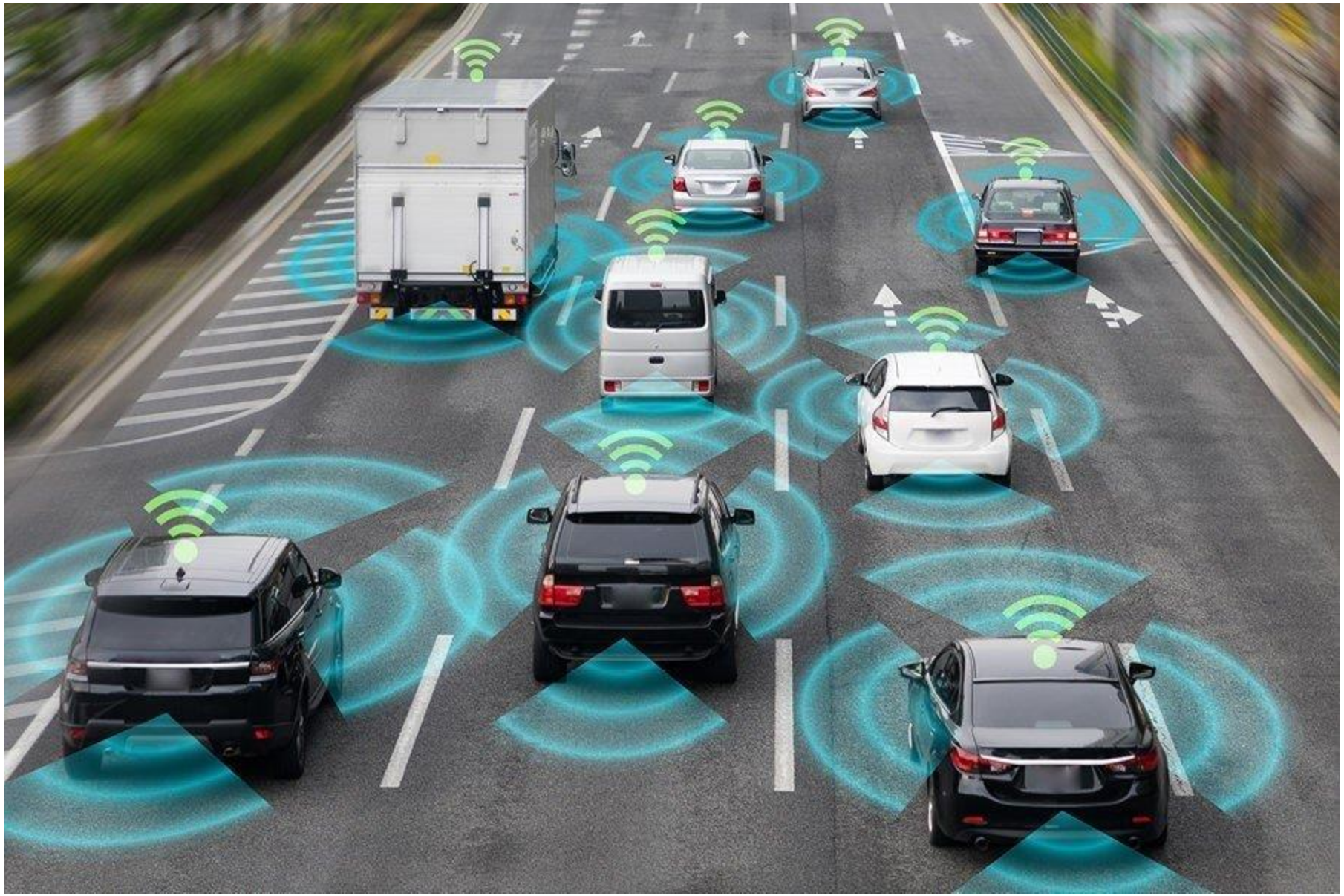
-To measure speed of the vehicle (5 km/s to 200 km/s)

-To measure length of the vehicle (0.1 m to 10's of m)

Extremely Sensitive – can detect even hand movement

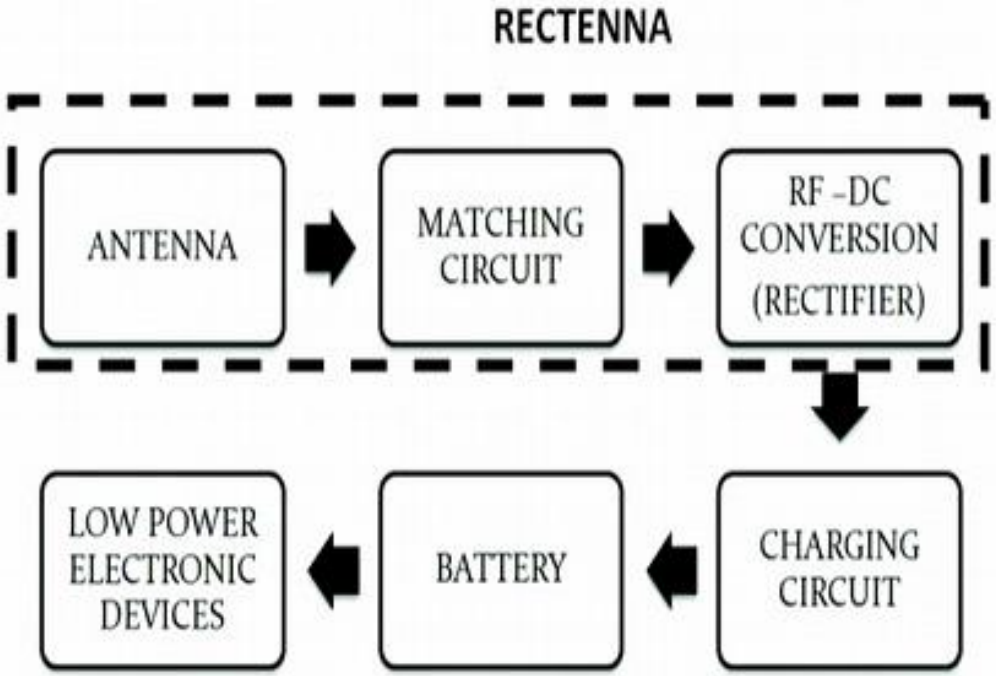
77 GHz Radar System

Collision Avoidance for the vehicle



9 – ENERGY HARVESTING SYSTEM

RF Energy Harvesting System



When a call was initiated using a cell phone in close proximity to RF Energy Harvesting system, it generated a DC voltage of 6.76 V, which is sufficient to charge a battery.

10 – MW EQUIPMENT

Microwave Equipment

Microwave Generator

Network Analyzer

Spectrum Analyzer

Microwave generators:

- There are many types of microwave generators, Generate output of only up to **one** gigahertz or up to **3** gigahertz or **10** gigahertz or **20** gigahertz and up to **100** gigahertz also.
- MW generators use amplitude modulation or frequency modulation or it may have a digital modulation built in two way. So, you can get a modulated signal output also.
- in microwave generator you can change the frequency from a low frequency (kilohertz) to a higher frequency (gigahertz) and the output power also can be changed from a very small value (-100 dB to up to +10 to +20 dBm).

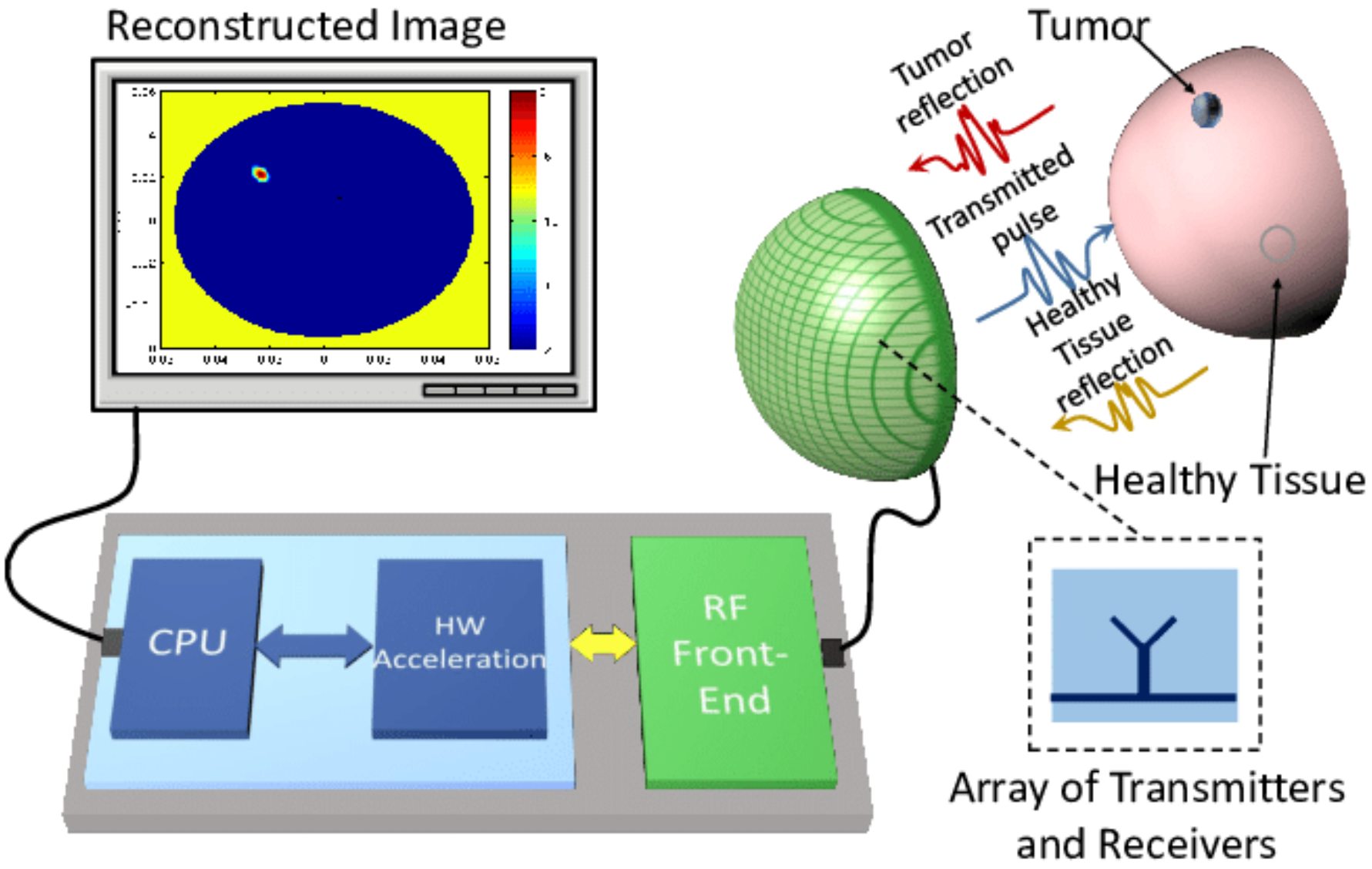
Spectrum Analyzer:

- a spectrum analyzer. Basically, spectrum analyzer is a equipment which measures the spectrum of a given signal. in spectrum analyzer majority of the time what should do you actually set the start frequency and the stop frequency and then you can see the spectrum of a given signal.

Network Analyzer:

- network analyzer is used to measure the S-parameters of a device S-parameters also we will discuss in more detail, but just in a simple form suppose if this device is an amplifier. So, we connect the input over here we connect the output over here. So, you can actually measure the gain of the amplifier.

11 – MW IMAGING



Breast Cancer Detection

Target under Test

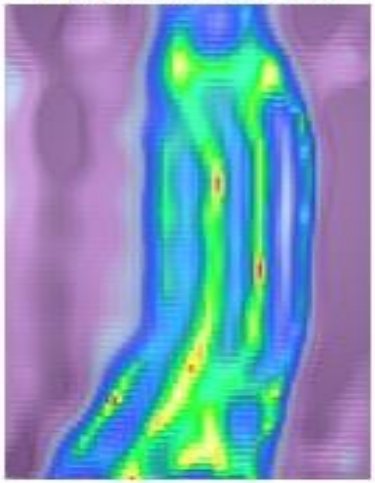
Human arm

Human palm

Sedated rat

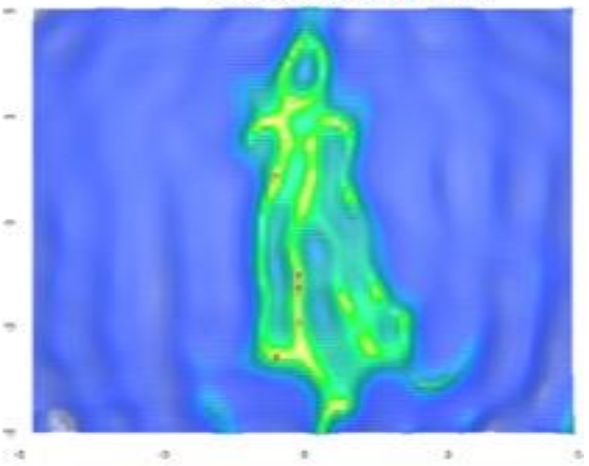
Microwave Images

Human arm



Human palm

Sedated rat



12 – HIGH POWER MW SYSTEMS

High Power Microwave Systems

Communication Range is increased

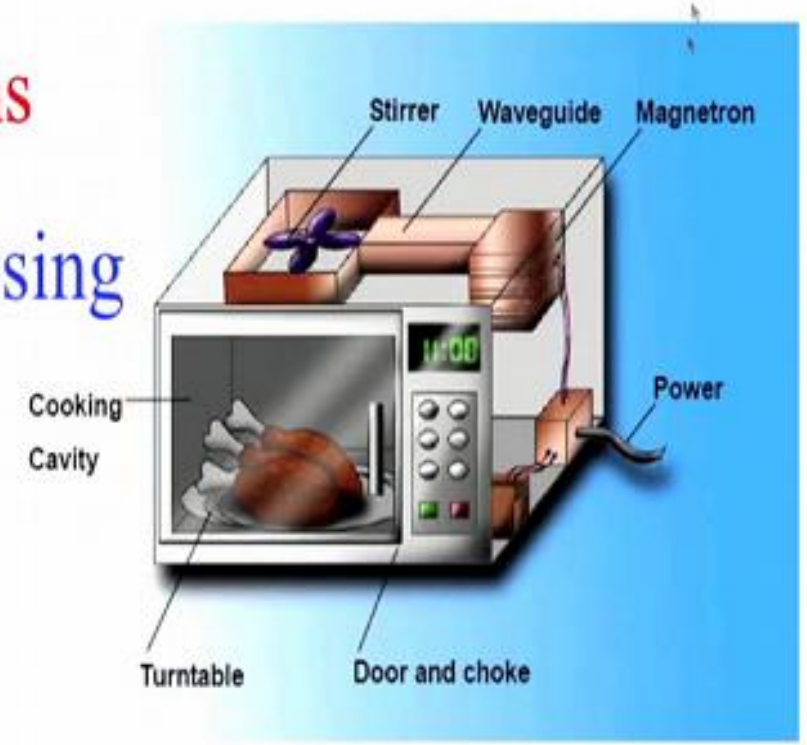
Microwave Heating Applications

- Cooking, Drying, Food Processing

- Hyperthermia

Microwave Bomb

Microwave Weapon



http://www.cfs.gov.hk/english/programme/programme_rafs/programme_rafs_ft_01_02_mcfs.html

❑ Microwave Oven

Construct of a **power supply**, **transformer** which goes to magnetron that **magnetron** generates a microwave frequency at 2.45 gigahertz through the **waveguide** then travels into the **cavity** where multiple reflection takes place.

❑ Microwave bomb

➢ an extremely high power microwave can be use as microwave bomb.

(transmitter with a very high power of small pulse & a wide bandwidth) this actually is used to destroy all the receivers. So, once a microwave bomb is put most of the receivers which actually work at a very low received power when they receive this very high power these receiver input signal get burned.

❑ Microwave weapon

used for crowd dispersal تفريق الحشود

Thank you for your attention