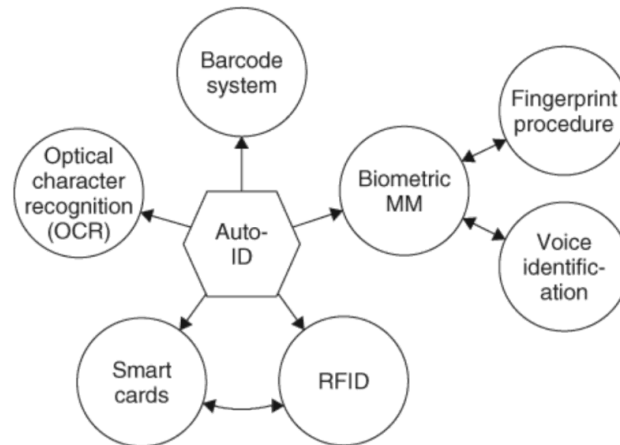**EBU6408 Radio Frequency Identification (RFID) and Sensors**
Tutorial 1 Solution

I.   RFID Architecture

Problem 1
What are the different types of automatic identification systems?
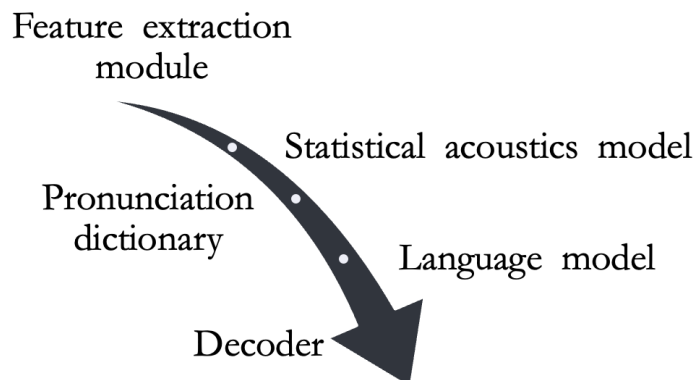**Solution**

Problem 2
a.   What are the steps to perform speech recognition?
b.   What are the technical features of speech recognition?
Solution
a.

b.

Easy to use, and easily accepted by the user

Cheap sound equipment, and not involve user's privacy

Due to the lack of international standards, there are some
difficulties in promoting

Problem 3
a.   What is the most popular barcode? In which industry it was first introduced?
b.   What are the main differences between 1D and 2D barcode recognitions?
c.   Is RFID better than using bar codes? Will RFID ever completely replace bar codes?
Solution
a.   The most popular barcode by some margin is the **EAN code (European Article Number)**, which was designed specifically to fulfil the requirements of the grocery industry in 1976.
b.   1D barcode recognition:
      o   Limited storage capacity, need to combine with the database.
      o   The barcode size is relatively large, the space utilization is low.
      o   Fault tolerance is poor, cannot restore the information after the corruption.

- 2D barcode recognition:
  - o **Large storage capacity**. Up to 32KB.
  - o **High information density**. Can store text, sound, pictures and other information.
  - o **Powerful error correction capability**. 2D code can still be identified in the case of 50% defacement.
  - o **Support for encryption**. Multiple security features.

c.

	(barcode image)	(RFID tag image)
Read Rate	Only one at a time	10's, 100's 0r 1000's simultaneously
Read Range	Several inches upto several feet	Passive UHF RFID: -Up to 40 feet (fixed readers) -Up to 20 feet (handheld readers) Active RFID -Up to 100's of feet or more
Read Speed	Slow	very fast (ms)
Readable through objects	No, must be line of sight	Yes
Identification	Most barcodes only identify the type of item (UPS Code) but not uniquely	Can uniquely identify each item/asset tagged

asset∞

Three advantages of using RFID compared to bar code scanning are:
- More efficiency: you can scan multiple items at once
- More durability: tags can handle exposure to weather conditions like sun and rain
- More security: you can encrypt RFID tags so only your reader can get the data

Problem 4

Describe the main features of RFID? Describe them.

Solution

1. **Non-contact automatic and rapid identification**
   The RFID tag returns data by backscattering the energy, with an effective communication range of 6-10 m.
   The RFID system uses an effective anti-collision mechanism to read tags, enabling rapid identification of a large number of tags.
2. **Permanently store a certain amount of data**
   RFID tag has a user storage area, which can store 1KB-10KB of user data.
3. **Simple logical processing**
   RFID has a very limited number of internal logic gates, so only a simple logical processing can be made. But the RFID system can use the basic logic processing ability of tags to achieve some effective protocols and algorithms to improve the system operating efficiency and security performance.
4. **Reflection signal strength is affected by the distance and other factors significantly**
   Since the RFID tag itself is a passive device, the feedback signal must be modulated by backscatter. Therefore, the strength of the RFID tag reflection signal is susceptible to the surrounding environment, including distance, reader power, signal interference, and tag deployment density.
5. **Low cost, can be deployed at a large scale**
   RFID tags tend to large-scale mass production using printed circuits, so manufacturing costs can be significantly reduced. At present, the cost of an RFID tag can be controlled at around 10 cents.

Problem 5

a. To which year RFID dates back?

b. When EPCglobal started to standardize RFID?

Solution

a. RFID wasn't officially patented until 1973, in a landmark claim by Mario W. Cardullo, who created an active RFID tagging system that utilized rewritable memory. RFID started as early as World War II, where airplanes used to be identified as "friend or foe" using this technology.

b. In 2003, EPCGlobal systems came to being and they started standardizing RFID from all possible directions.

Problem 6

What are the major frequency ranges at which RFID systems operate?

Solution

Table 3.1   RFID Summary Table

Frequency	Range	Tag Cost	Applications
Low frequency (125–148 kHz)	3 feet	$1+	Pet and ranch animal ID; car key locks
High frequency (13.56 MHz)	3 feet	$0.50	Library book ID; clothing identification; smart cards
Ultrahigh frequency (915 MHz)	25 feet	$0.50	Supply chain tracking: box, pallet, container, trailer tracking
Microwave (2.45 GHz)	100 feet	$25+	Highway toll collection; vehicle fleet ID

Problem 7

There are four major frequency ranges at which RFID systems operate. As a rule of thumb, low-frequency systems are distinguished by short reading ranges, slow read speeds, and lower cost. Higher-frequency RFID systems are used where longer read ranges and fast reading speeds are required, such as for vehicle tracking and automated toll collection. Microwave requires the use of active RFID tags. Answer the following questions:

a. You are planning an RFID system for tracking the location of people within the building. What frequency band(s) would you consider for this application? Elaborate your answer.

b. You are planning an RFID system for counting a large number of fastmoving and cheap products on the conveyer belt. What frequency band(s) would you consider for this application? Elaborate your answer.

c. You are planning to deploy RFID system, but the environment already contains a large WLAN network with many users. What RFID bands may not be suitable for your system? Elaborate your answer.
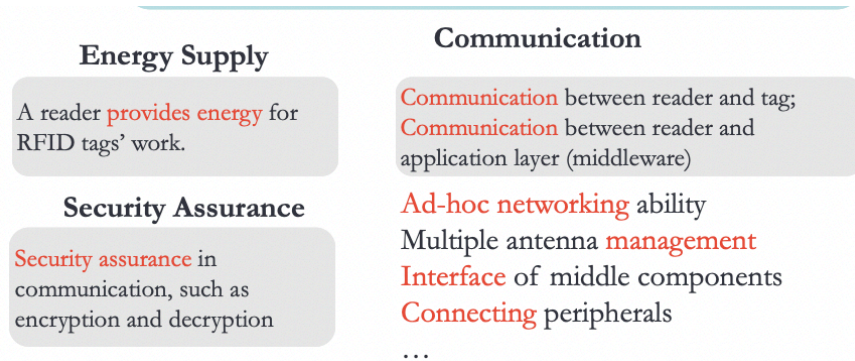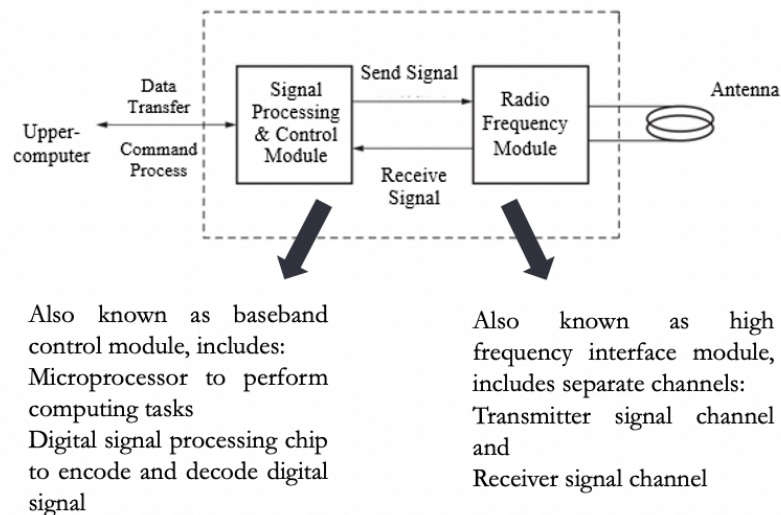
II.   RFID Architecture

Problem 1

  a. What are the reader's main functions?
  b. What are the main components of RFID reader?
  c. What are the two types of RF modules and how different they are?

Solution (from Slides)

a.

Energy Supply

A reader provides energy for RFID tags' work.

Security Assurance

Security assurance in communication, such as encryption and decryption

Communication

Communication between reader and tag; Communication between reader and application layer (middleware)

Ad-hoc networking ability
Multiple antenna management
Interface of middle components
Connecting peripherals
…

b.

Also known as baseband control module, includes:
Microprocessor to perform computing tasks
Digital signal processing chip to encode and decode digital signal

Also known as high frequency interface module, includes separate channels:
Transmitter signal channel and
Receiver signal channel

c. Induced coupling and electromagnetic backscattering (see slides for more details).

Problem 2
a. What are the different package forms for RFID tags?
b. What is the difference between passive and active tags?
c. What are the main components of RFID tags? Describe them.
Solution (from Slides)
Problem 3
Define the RFID middleware. What is its main function?
Solution (from slides)
Problem 4
What do you think about the idea of passive RFID devices for locating small children?
Solution (from slides)
Problem 5
You want a RFID tag that supports longer distance communications and does not rely on the reader to provide power to the tag. What kind of tag(s) do you need? Discuss advantages and disadvantages of these tags.
Solution (from slides)
Problem 6
Solution
a. C = 331 pF.
b. f_1 = 117.96 kHz.