Unit 2: Hardware for IoT

❖ Sensors

- **What are IoT Sensors?**
- IoT sensors are pieces of hardware that detect changes in an environment and collect data.
- They’re the pieces of an IoT ecosystem that bridge the digital world to the physical world.
- IoT sensors may detect things like temperature, pressure, and motion, and if they are connected to a network, they share data with the network.

Types of IoT Sensors

- There are many different types of sensors, and they come in different shapes and sizes.

Temperature Sensors

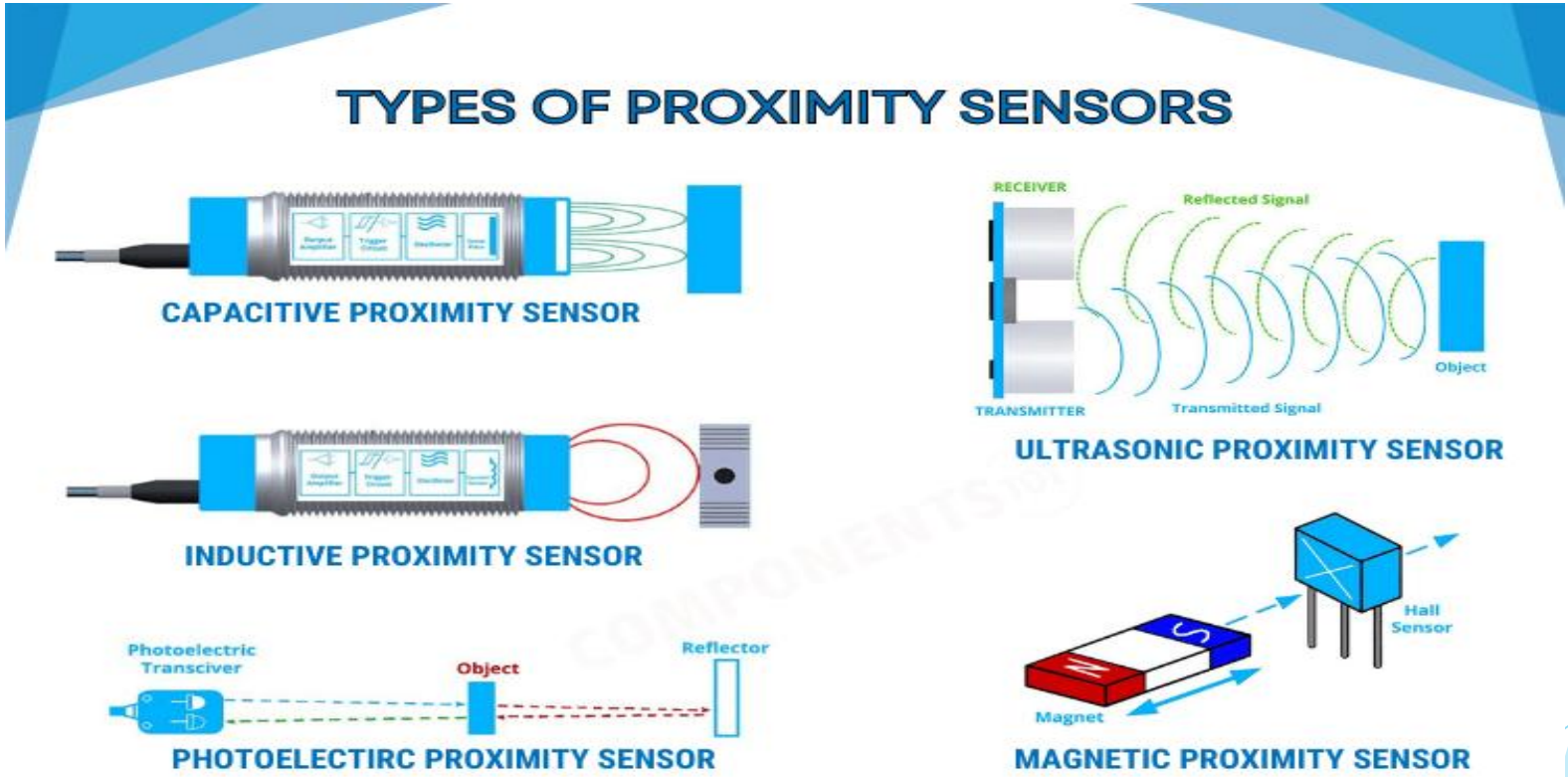
- Temperature sensors measure the amount of heat generated from an area or an object. They detect a temperature change and convert the findings to data. Temperature sensors are used in various industries, including manufacturing, healthcare, and agriculture. Some examples are thermistors, thermocouples, and resistor temperature detectors (RTD)

Proximity Sensors

- Proximity sensors detect the presence or absence of objects near the sensor without physical contact.
- They often emit a beam of radiation like infrared or an electromagnetic field.
- They can be used for process monitoring and control, object counting, assembly lines, and determining available space.
- *Proximity sensors are common in retail settings, industrial complexes, and parking lots.*

https://youtu.be/SsvjxnN8ZUk?si=eENeLZhGl9s8j3Tz

Some examples are photoelectric, magnetic, capacitive, inductive, and ultrasonic.



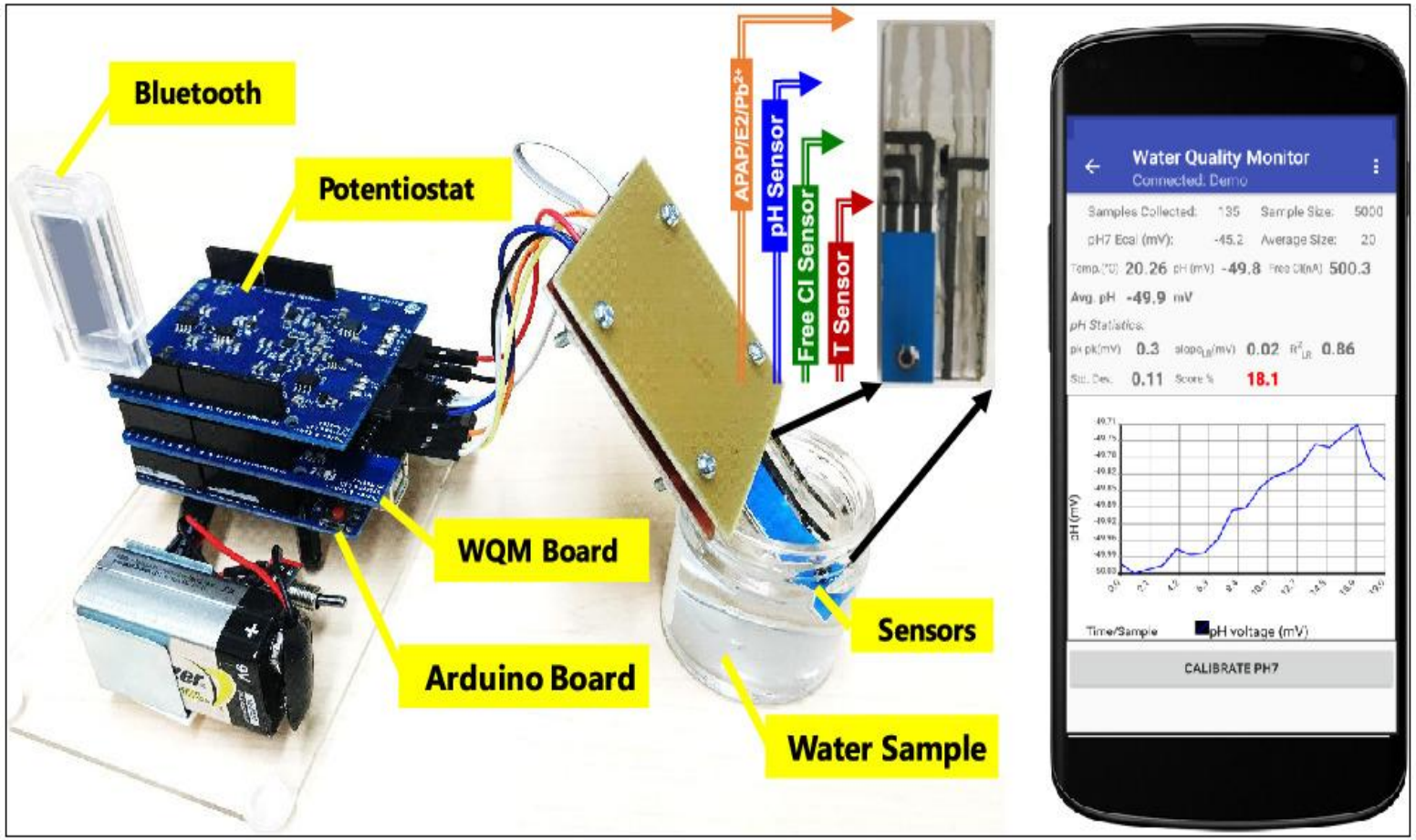
Pressure Sensors

- These sensors *detect changes in a gas or liquid*.
- When the pressure range is beyond a set threshold, pressure sensors alert to the problem.
- They are used for leak testing, water systems, vehicles, and aircraft. For example, the BMP180 is a digital pressure sensor found in cell phones and GPS navigation devices. And some vehicles use a tire pressure monitoring system (TPMS) to alert when tire pressure is low and potentially unsafe.

Water Quality Sensors

- As you'd expect, water quality sensors monitor the quality of water.
- There are different kinds of water sensors, including residual chlorine sensors, turbidity sensors, pH sensors, and total organic carbon sensors.

Application



Digital sensors

- Digital sensors produce a discrete digital voltage or signal that is considered to be a digital representation of a measurement.
- This sensor will display binary output in ones and zeros. Digital sensors tend to be considerably less expensive when compared to analog ones.
- These sensors are known to have a fast transmission rate.

What Can Digital Sensors Measure

- Among the most common measurements that can be recorded by a digital sensor include conductivity, pH levels, ammonium concentration, nitrate concentration, and dissolved oxygen.
- While standard digital sensors provide accurate results, a more advanced type of digital sensor is oftentimes referred to as a smart sensor.
- Smart sensors are used to modernize and streamline measurements through digital and wireless communication.

The five types of smart sensors that are commonly incorporated into industrial environments include:

Level Sensors

- These are sensors that can measure how much volume space takes up in a container of any size.
- For instance, the fuel gauge in a car could be connected directly to one of these sensors, which will monitor how much fuel remains in the tank.

Pressure Sensors

- These sensors are typically used to monitor fluid and gas pressure in a pipeline

Temperature Sensors

- These sensors are designed to monitor the temperature of a component to determine if and when corrective actions may need to be taken

Infrared Sensors

- Digital infrared sensors can come in several different forms.
- This type of infrared sensor is mainly used in different types of medical equipment, the primary use of which include pulse oximetry devices.

Proximity Sensors

- Proximity sensors are designed for detecting the location of an object or person as it pertains to the sensor itself.

Analog Sensors

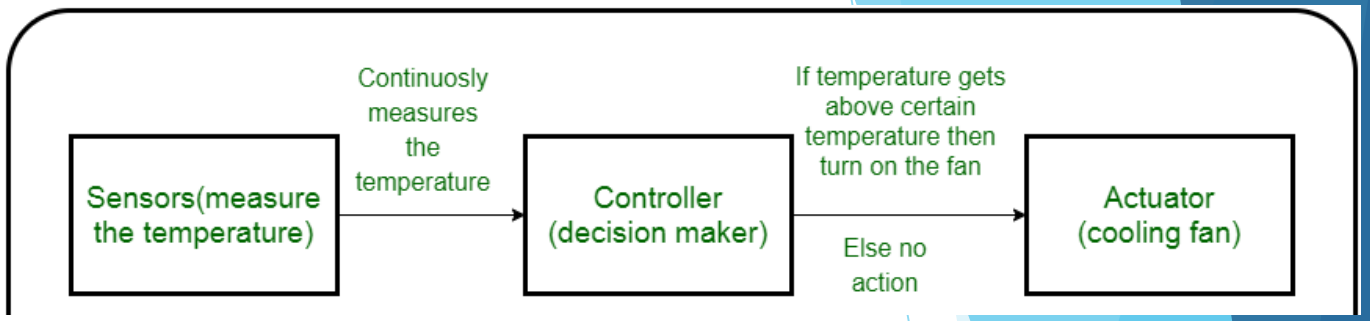
- Analog sensors are much different than digital sensors and typically have less features.
- These sensors, which is a continuous signal that represents a quantity.
- The analog quantities that are **known to be continuous in nature include speed, pressure, displacement, strain, and temperature.**
- While there are many types of analog sensors, among the most common type is a pressure sensor, which is commonly used in industrial and lab settings to manage the pressure of liquids or gases.

- Write any 5 difference between Analog and Digital Sensors.

Difference between Analog and Digital Sensors.

Analog Signals	Digital Signals
Continuous Signals are present.	Discrete signals.
Represented by sine waves.	Represented by square waves.
A continuous range of values.	Discontinuous values.
Only used in Analog Devices.	Suited for digital electronics like computers and mobile phones.
Records sound waves as they are.	Converts into binary waveform.
The human voice and natural sound are some examples.	Computers and optical devices are some examples.

Actuators



- An actuator is a machine component or system that moves or controls the mechanism of the system. Sensors in the device sense the environment, then control signals are generated for the actuators according to the actions needed to perform.
- A servo motor is an example of an actuator. They are linear or rotatory actuators, can move to a given specified angular or linear position. We can use servo motors for IoT applications and make the motor rotate to 90 degrees, 180 degrees, etc., as per our need.
- The following diagram shows what actuators do, the controller directs the actuator based on the sensor data to do the work.

Sensor | Control Center | Actuator

Temperature sensor detects heat.

Sends this detect signal to the control center.

Control center sends command to sprinkler.

Sprinkler turns on and puts out flame.

Sensor to **Actuator** Flow

Participatory sensing technology

- Information collected from sensors of multiple heterogeneous sources can lead to knowledge discovery after analytics and data visualization.
- A web source defines Participatory Sensing (PS) as “sensing by the individuals and group of people contributing sensory information to form a body of knowledge”.
- “Participatory sensing is the *process whereby individuals and communities use evermore-capable mobile phones and cloud services to collect and analyse systematic data for use in discovery*.”

- A participant of a PS process can be sensors used in mobile phones. Mobile phones have camera, temperature and humidity sensors, an accelerometer, a gyroscope, a compass, infrared sensors, NFC sensors, bar or QR code readers, microphone and GPS. Mobiles communicate on the Internet the sensed information with time, date and location stamps

- Applications of PS include retrieving information about weather, environment information, pollution, waste management, road faults, health of individuals and group of people, traffic congestion, urban mobility, or disaster management, such as flood, fire, etc. Participatory sensing has many challenges such as—security, privacy, reputation and ineffective incentives to participating entities

7.3.1 Industrial IoT

- (IIoT) involves the use of IoT technology in manufacturing.
- IIoT involves the integration of complex physical machinery M2M communication with the networked sensors and use of software, analytics, machine learning and knowledge discovery.
- Example functions of IIoT are refining the operations for manufacturing or maintenance, or refining the business model of an industry.


TechTarget

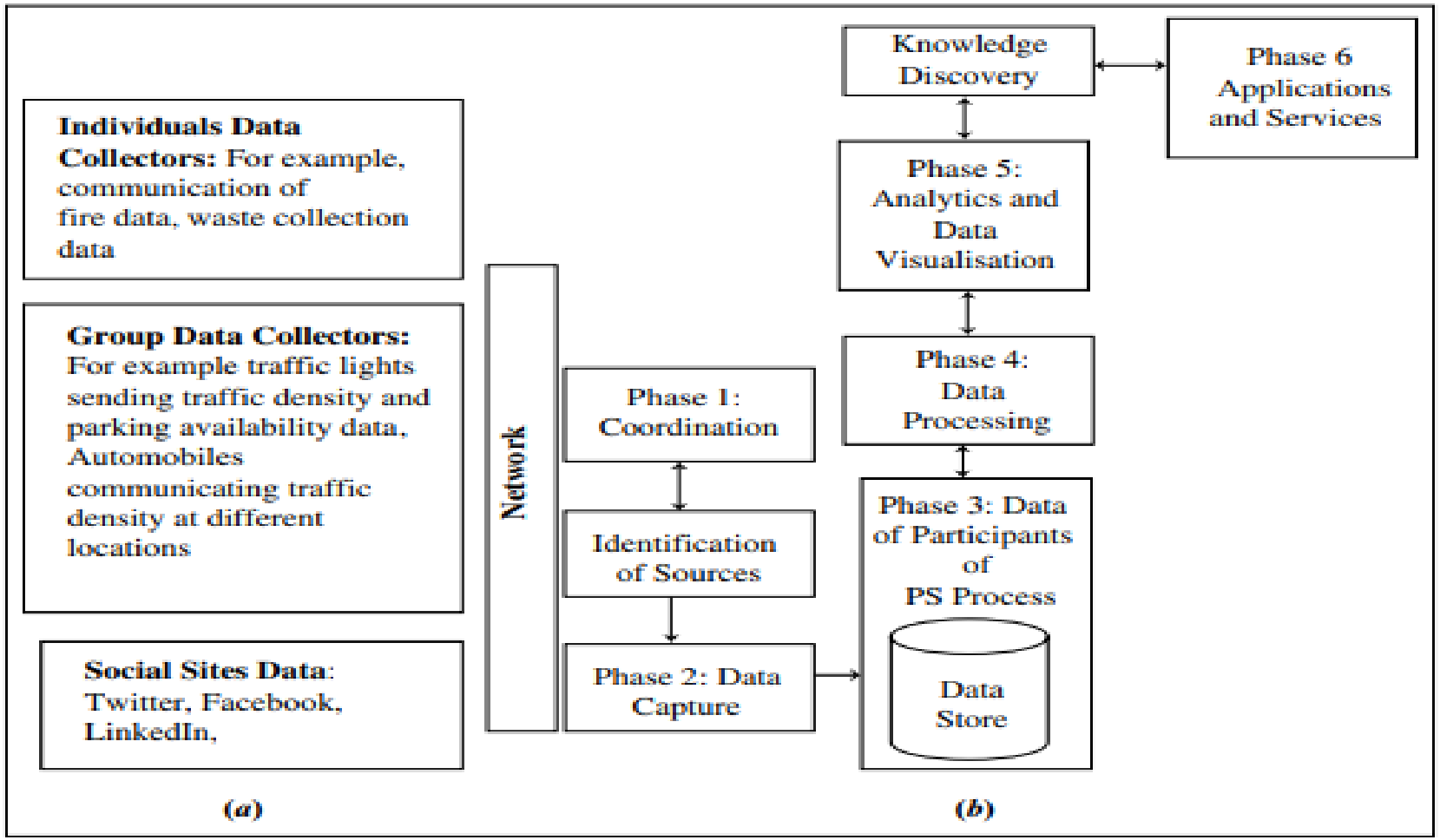


Figure 7.9 (a) Sources of data in the PS processes and (b) Phases of a participatory sensing process for IoT applications and services

IoT applications are in the manufacturing, railways, mining, agriculture, oil and gas, utilities, transportation, logistics and healthcare services.

How is IIoT technology used in optimising the bicycle manufacturing process?

- **Real-time Tracking** – Sensors monitor each stage of bicycle manufacturing and send updates on progress.
- **Issue Detection** – The IIoT system analyzes delays, breakdowns, and failures to identify bottlenecks.
- **Optimized Production** – The system helps fix issues, manage supply, and ensure smooth manufacturing.
- Figure 7.10 shows IIoT phases in the bicycle manufacturing process

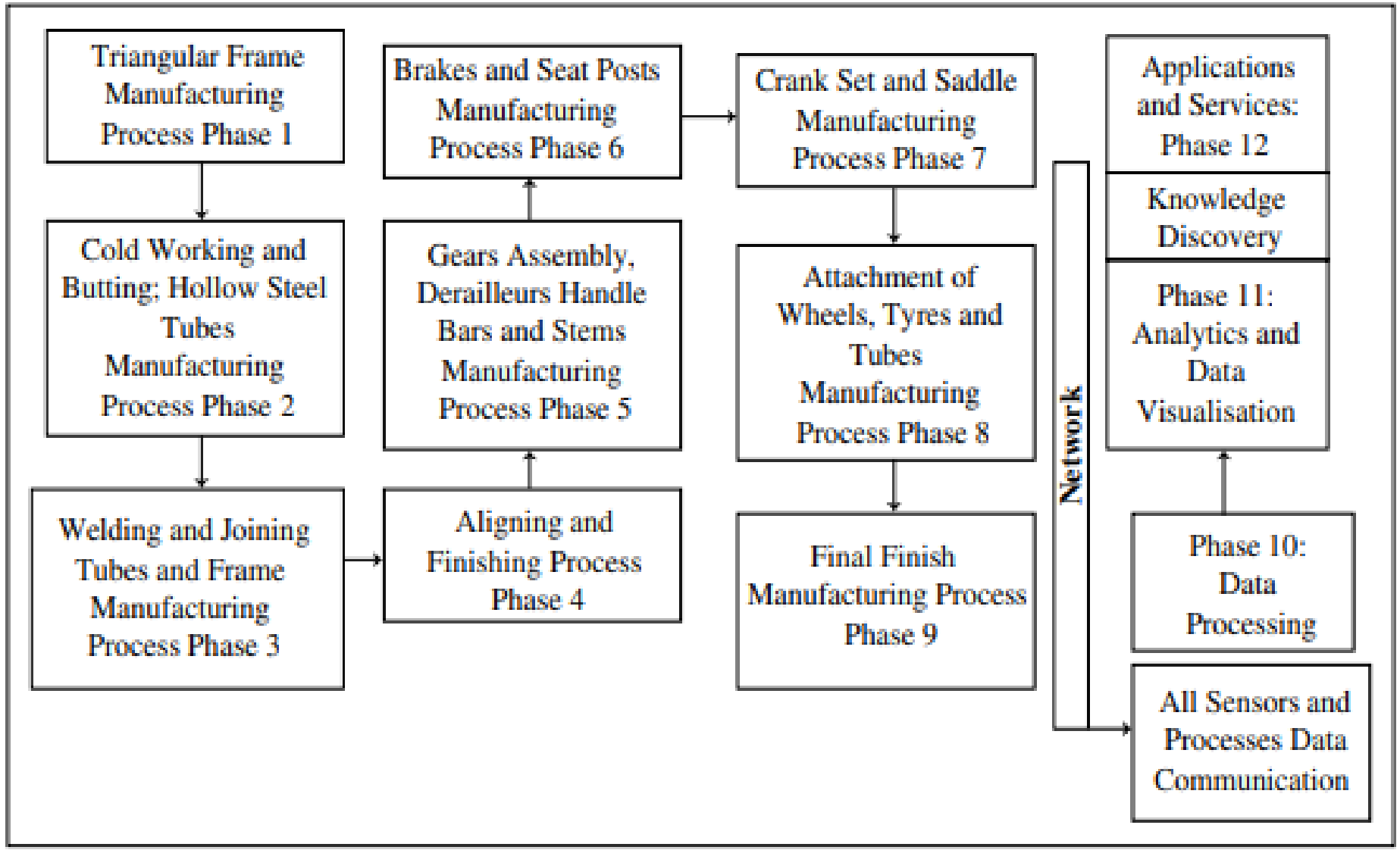


Figure 7.10 IIoT phases in the bicycle manufacturing process

7.3.2 Automotive IoT

- Automotive IoT enables the connected cars, vehicles-to-infrastructure technology, predictive and preventive maintenances and autonomous cars.

Connected Cars Technology

1. Display for driver that enables driving through the shortest route, avoiding the congested route, etc.
2. Customisation of functioning of the vehicle to meet the driver's needs and preferences.
3. Get notifications about traffic [https://youtu.be/2VsFwCs2Q2M]
4. Protecting cars against theft
5. Weather and enroute destinations
6. Keeping a tab on driver's health and behaviour.

Vehicle-to-Infrastructure Technology

- Automotive IoT enables Vehicle-to-Infrastructure (V2I) technology.
- A vehicle communicates with other vehicles, the surrounding infrastructure and a Wi-Fi LAN.

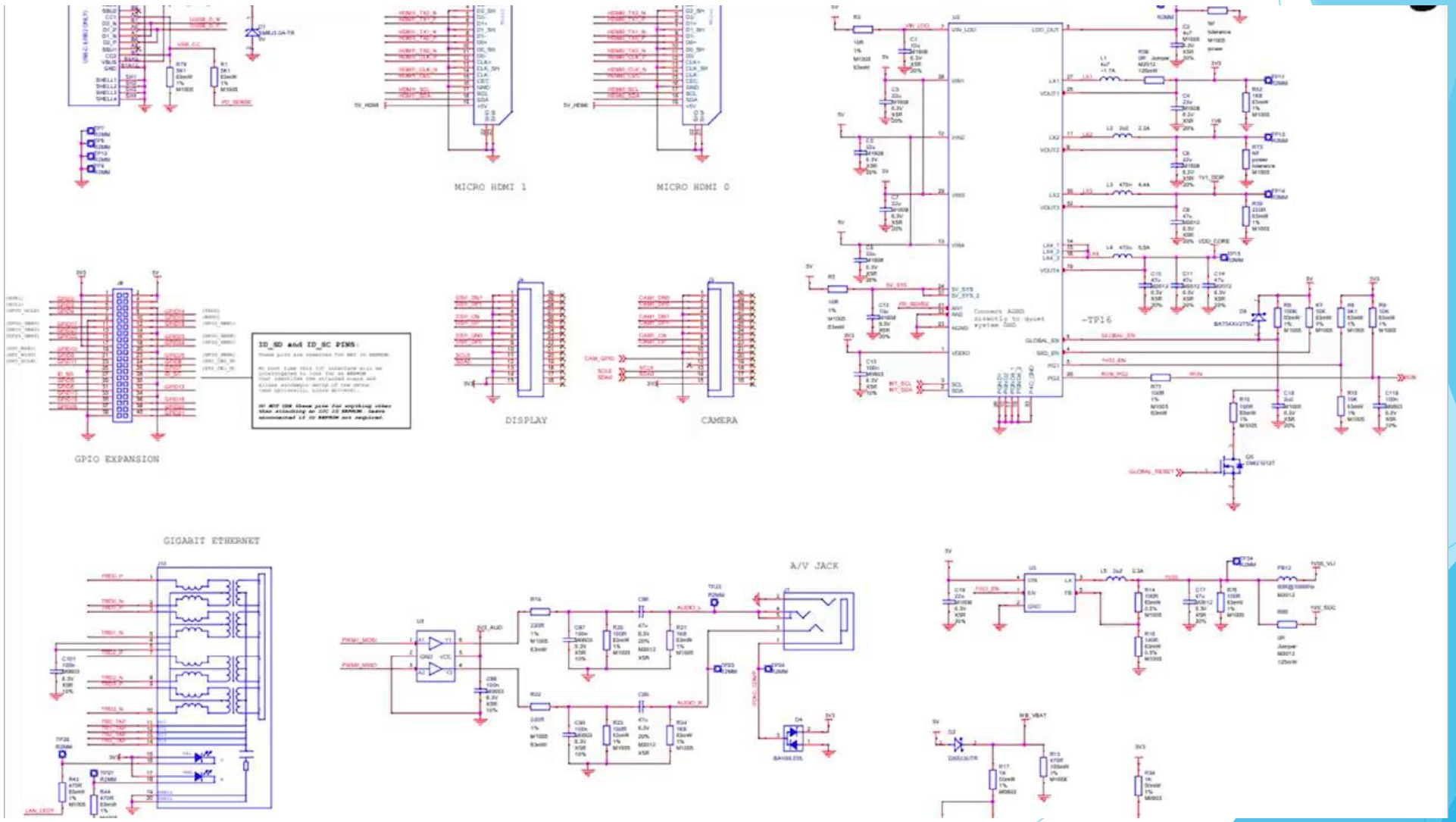
Examples of V2I applications are:

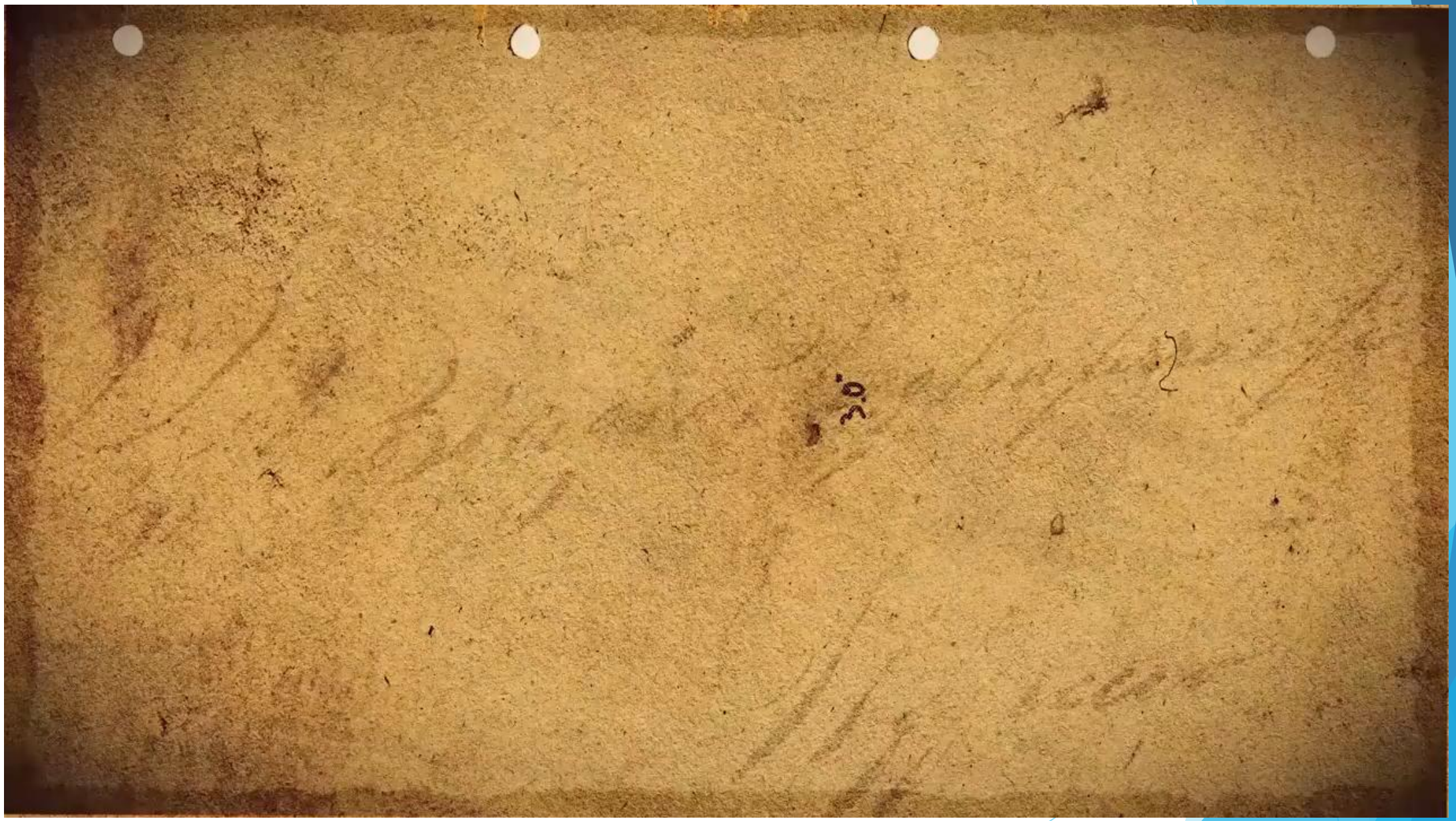
- Alerts and warnings for forward collision
- Information about blind spots
- Notification about a vacant parking space
- Information about traffic congestion on route to destination
- Stream live music and news

- Predictive and Preventive Maintenances-283

Overview of IOT supported Hardware platforms:

Raspberry pi





- Radio Frequency IDentification (RFID) technology

Wireless Sensor Networks

Embedded Platforms for IoT: Embedded computing basics

Unit 2

- Sensors, Digital sensors, actuators, radio frequency identification (RFID) technology,
- wireless sensor networks, participatory sensing technology. Embedded Platforms for IoT: Embedded computing basics,
- Beagle Bone, Intel Galileo boards and ARM cortex.