Theme no. 1

Smart Greenhouse

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1) **Applicability domains**
   a. **Use-cases**

   The applicability domains we have chosen to improve using IoT are agriculture and retail. Some of the use-cases are:

   - Soil monitoring: With IoT-enabled soil monitoring, farmers can gather real-time data on key soil parameters such as moisture, temperature, pH, and nutrient levels. This data can help farmers optimize their crop yields, reduce water usage, and minimize the use of fertilizers and pesticides.
   - Temperature and humidity monitoring: Maintaining optimal temperature and humidity levels is critical for the growth and health of many crops, and IoT-enabled sensors can help farmers monitor and control these conditions in real-time.
   - Supply chain management: IoT sensors can be used to track the location and condition of crops as they move through the supply chain, ensuring that they are handled properly and delivered to their destination on time.
   - Choosing the crops to be grown: One of the most important parts for agriculture is to be profitable, so using IoT by collecting data about customers demands and the cost of growing them, the seeds for the crops to be grown can be ordered.

   b. **One of the use-cases is chosen and the system is defined in details**

   Choosing the crops to be grown is an important part of agriculture because it directly influences the profit. Using IoT we can design a system that decides which are the best plants to be ordered based on numerous factors like customers preferences and the cost of growing. To start with, the system will collect data about the nutrients present in the soil (different plants need different nutrients to be able to grow at full potential) using different kinds of sensors. Also, data about the humidity and temperature will be collected to estimate the general climate of our location. This data will be sent in the cloud where they will be analyzed. The application also collects data from different websites about the most sold kinds of crops and the conditions they need to grow in order to be good. After this, the application will estimate how much money is needed to create the proper conditions for each chosen plant and will determine which ones have the best cost-income ratio. Based on this decision, the application will automatically order the seeds and the other elements needed for the proper growing of the plant.

2) **System definition**
   a. **Components that enter the system infrastructure**
      - the sensors that will monitor the conditions of the environment: temperature, humidity, soil nutrients;
      - the components of the agriculture that will be controlled based on the sensors information: sprinklers, radiators, air conditioning, moisture absorbents, windows, lights, etc.;
      - the hub where the information will be sent, and the components will be managed;
      - routers and access-points that connect all the devices;
      - internet connection for the hub is needed to send orders for seeds and different materials needed;
   b. **Protocols used in communication processes**
      - MQTT (Message Queuing Telemetry Transport): MQTT is a widely used protocol for IoT devices with limited computing resources. It is suitable for low-bandwidth, high-latency networks and is commonly used in smart greenhouse systems for sensor data transmission, control commands, and status updates.
      - CoAP (Constrained Application Protocol): CoAP is designed for constrained devices and networks and is used for machine-to-machine communication in IoT applications. In smart greenhouse systems, CoAP can be used to transmit data and control commands between the greenhouse devices and the cloud.
      - ZigBee: ZigBee is a low-power wireless protocol suitable for communication among devices in smart greenhouse systems. It can be used to transmit sensor data, control commands, and status updates between devices.
      - Bluetooth: Bluetooth is a wireless protocol suitable for communication between nearby devices, making it ideal for smart greenhouse applications. Bluetooth can be used to transmit data and commands between the greenhouse control system and user devices, such as smartphones and tablets.
      - Wi-Fi: Wi-Fi is a widely used wireless protocol that is suitable for high-bandwidth applications. In a smart greenhouse, Wi-Fi can be used to connect the greenhouse system to the internet and the cloud, enabling data transmission, control commands, and system updates.
   c. **Process automation**
      - Seed selection: A process automation system can use data from sensors and other sources to analyze soil conditions and other factors to determine the best seed selection for the greenhouse. This system can also incorporate customer preferences, such as seed type and planting time, to optimize the crop yield.
      - Irrigation: IoT sensors can monitor soil moisture levels and send this data to the process automation system. The system can then use this data to automatically control the irrigation system, ensuring that plants receive the correct amount of water at the right time.
      - Lighting: Smart lighting systems can be used to simulate natural sunlight, providing the optimal light conditions for plant growth. The process automation system can automatically control the lighting system based on sensor data and other environmental factors to optimize plant growth and reduce energy consumption.
      - Temperature and humidity control: The process automation system can control the greenhouse's heating and cooling systems based on sensor data and other environmental factors, ensuring that plants grow in optimal conditions.

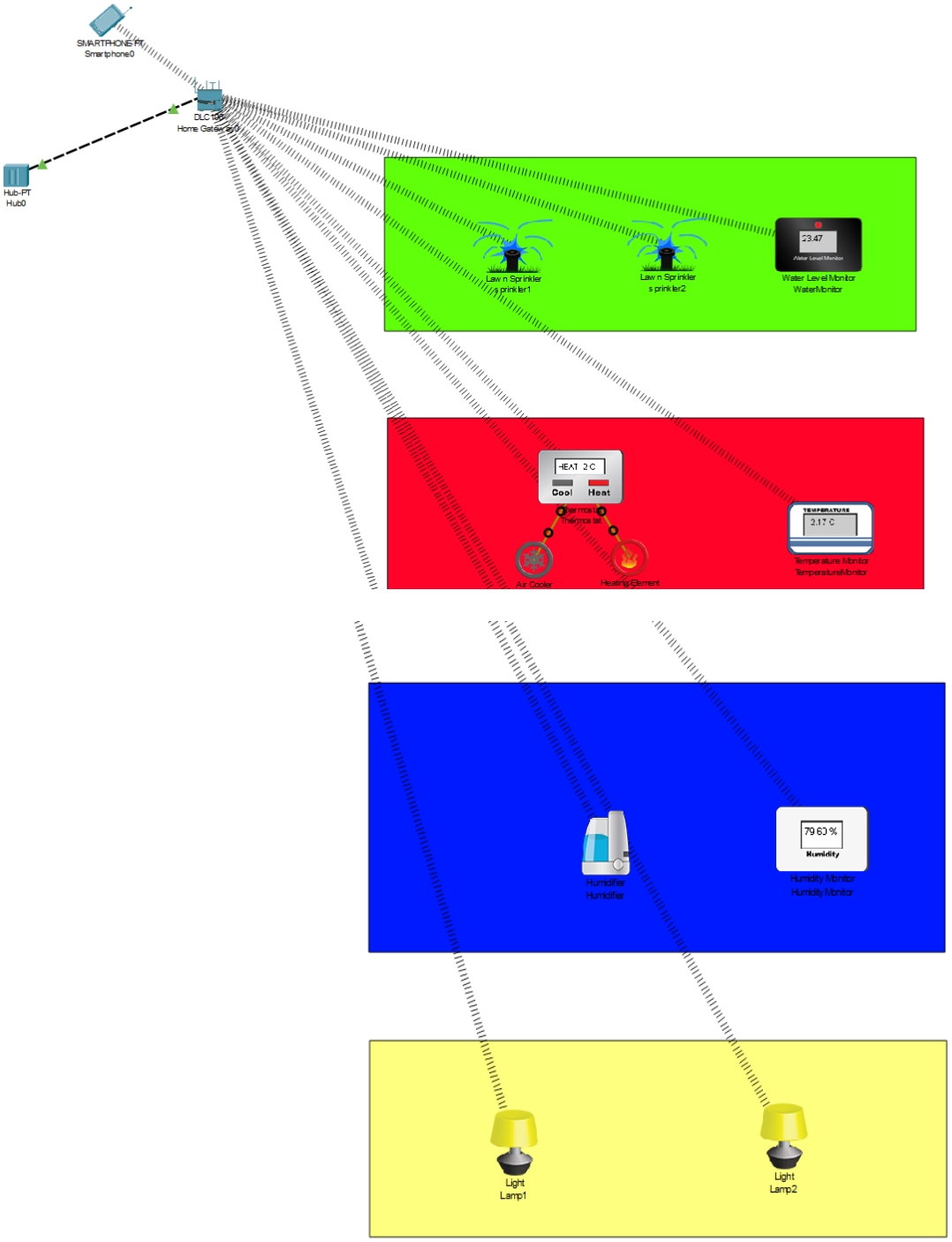
- Harvesting: The process automation system can use data from sensors and other sources to determine the optimal time for harvesting. The system can then automatically control the harvesting process, reducing labor costs and improving efficiency.

d. Estimated costs

- Sensors: 300 euros
- Communication devices and protocols: 25 euros per device with ZigBee communication, and 15 euros per device with Wi-Fi
- Control systems: 300 euros
- Internet connection: 20 euros per month

3) Cisco Packet Tracer

a. Print screen of architecture

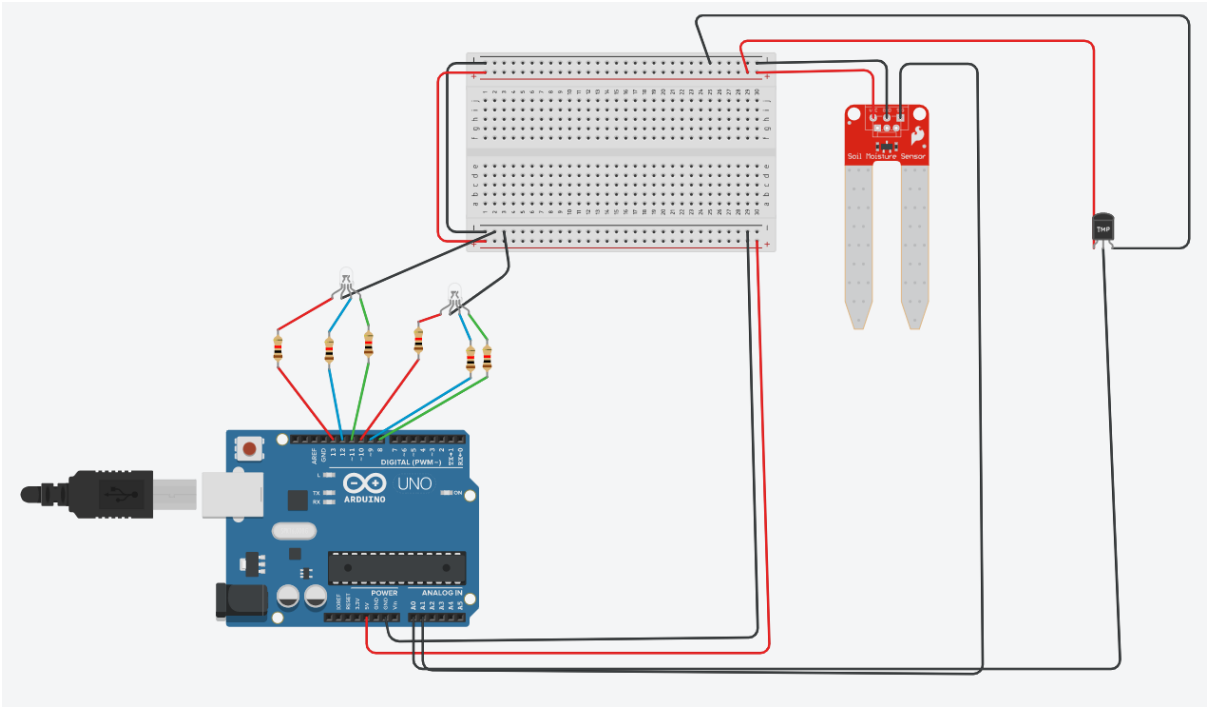


b. Implemented functionalities:

- The sprinklers and the water level monitor are connected to the home gateway and are managed using the smartphone. The gateway connects data from the components and sends them to the hub. When the water level is under 10 cm the sprinklers are automatically turned on and when it reaches 40 cm they are turned off.
- The temperature monitor and the thermostat are connected to the home gateway too. When the temperature is under 19 degrees Celsius, the heater is turned on and when it is above 20 degrees Celsius, the cooler is turned on.
- The humidifier and the humidity monitor are connected to the home gateway too. When the humidity level drops under 75, the humidifier is turned on and when it reaches 80, it is turned off.

4) TinkerCad

a. Print Screen of Architecture



b. Functionalities

The architecture has two main functionalities:

- Temperature measurement: The temperature sensors measures and lights the led in this way: if the temperature is under 15, the led is blue, if it is between 15 and 20, it is green and if it is above 20, it is red.
- Moisture measurement: A led is lighted by the arduino using the moisture sensor: if the moisture is under 50, the bulb is green, if it is above 50, it is red.