## LED Control with ESP32 Using Arduino IoT Cloud

This project demonstrates how to control an LED connected to an ESP32 using the **Arduino IoT Cloud** platform. The setup allows you to toggle the LED on and off remotely from a web or mobile dashboard.

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## Features of the System

1. **Arduino IoT Cloud Integration**:
    - Use Arduino IoT Cloud for remote control and monitoring.
    - Secure communication via a Thing ID and a Device Secret.
2. **ESP32**:
    - Acts as the microcontroller and connects to Wi-Fi.
    - Receives commands from the IoT Cloud to control the LED.
3. **LED**:
    - Turns on/off based on user input from the IoT dashboard.

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## Components Required

1. ESP32 microcontroller.
2. LED.
3. Resistor (220Ω recommended).
4. Breadboard and jumper wires.
5. USB cable for programming and power.

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## Arduino IoT Cloud Setup

1. **Create an Arduino IoT Cloud Account**:
    - Sign in or create an account at Arduino IoT Cloud.
2. **Create a New Thing**:
    - Go to **Things** > **Create Thing**.
    - Add a variable for the LED:
        - Name: `ledState`
        - Type: `boolean`
        - Permission: **Read & Write**
        - Update: **On Change**
3. **Configure the Device**:
    - Add your ESP32 as a device.
    - Follow the setup steps, and Arduino IoT Cloud will generate a Thing ID and Device Secret.

4. **Dashboard Creation**:
    - Go to **Dashboards** > **Create Dashboard**.
    - Add a toggle switch to control the `ledState` variable.

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## Pin Connections

| LED Pin | Connection | ESP32 Pin |
|---|---|---|
| **Anode (+)** | 220Ω resistor to GPIO | GPIO5 |
| **Cathode (-)** | Ground | GND |

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## How It Works

1. **Cloud Integration**:
    - ESP32 connects to Arduino IoT Cloud over Wi-Fi.
    - The cloud sends commands to update the `ledState` variable.
2. **LED Control**:
    - The ESP32 monitors the `ledState` variable.
    - Based on the variable value, it turns the LED on or off.

## Circuit Diagram

1. Connect the **anode (+)** of the LED to **GPIO5** on the ESP32 through a 220Ω resistor.
2. Connect the **cathode (-)** of the LED to **GND** on the ESP32.

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## Dashboard Configuration

1. Add a **Toggle Switch** widget in your IoT Cloud dashboard.
2. Link the toggle to the `ledState` variable.
3. Save and test the dashboard.

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## Results

1. **Web/Mobile Control**:
    - Toggle the LED on/off from the Arduino IoT Cloud dashboard.
2. **Real-Time Updates**:
    - Changes are reflected instantly on the device and dashboard.

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## Applications

1. **Smart Home Automation**:
    - Control lights and appliances remotely.
2. **IoT Projects**:
    - Integrate with other sensors and actuators for advanced systems.
3. **Learning Platform**:
    - Ideal for learning cloud integration with IoT devices.

This setup is a simple yet powerful demonstration of IoT in action, enabling remote LED control via the Arduino IoT Cloud.