Remote monitoring of Internet of Things

TEK5110- Building Mobile and Wireless Networks
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Why do we need remote monitoring?

- Ensure devices are in the desired state
- Anomaly detection
- Perform diagnostic
- Data collection for decision making
  - Maintenance planning
  - Capacity planning

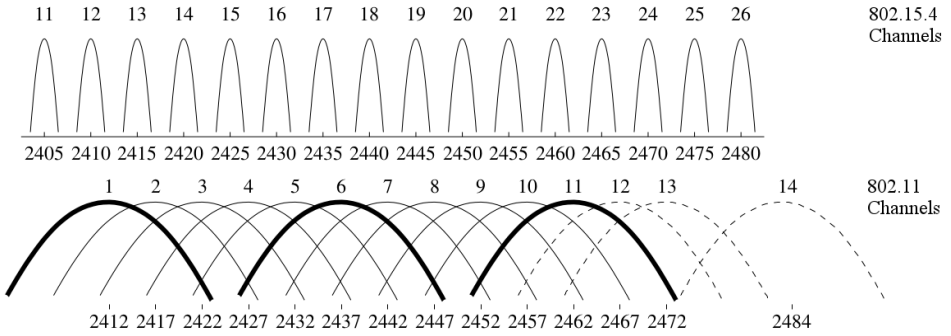
Energy remote monitoring?

- Smart electricity meters
  - Allow electricity providers to monitor consumption, voltage, current, and power factor thus issuing customer billing.

- Power tags
  - Energy sensors capable of monitoring energy parameters such as voltage, current, and frequency in real time. Generally, power tags are designed for residential and small business buildings.

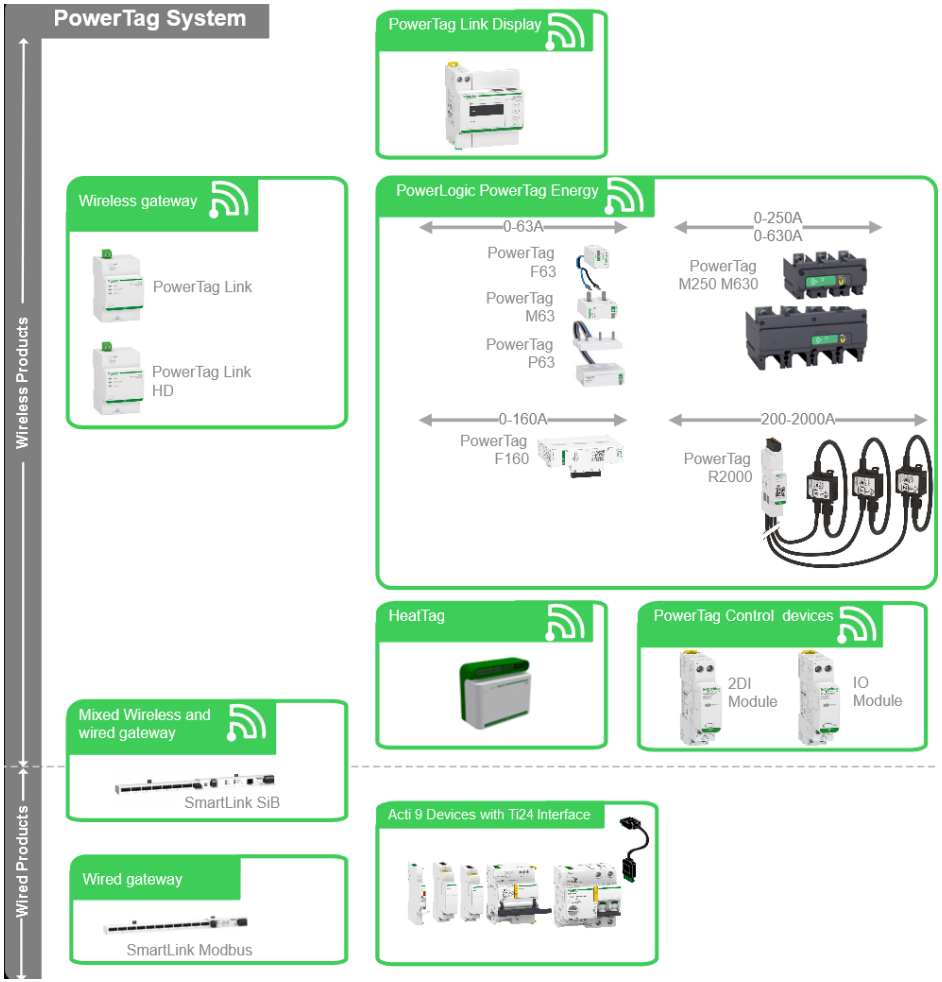
Power tag link gateway

- Controlling up to 100 wireless power tags
- 100 Mbps Ethernet port for management by BMS, PMS or SCADA
- 3 meters maximum distance between gateway and wireless devices
- Uses ISM band 2.4 GHz (2.4-2.4835 GHz) in accordance with IEEE 802.15.4 (LR-WPAN) standard
- Each channel is 2 MHz wide with 5 MHz spacing between channels
- Maximum 8 Modbus TCP, 2 HTTPS and 5 HTTP connections



https://inet.omnetpp.org/docs/showcases/wireless/coexistence/doc/index.html

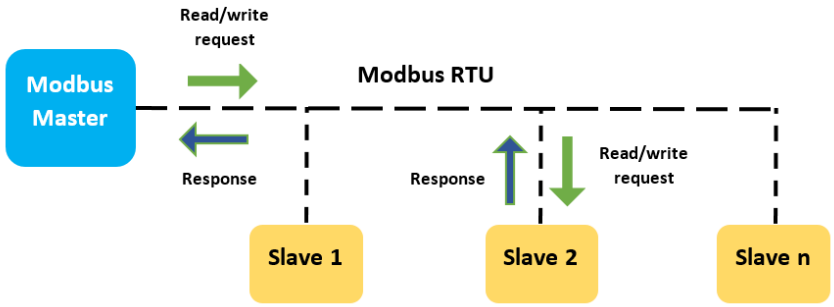
Energy monitoring components



https://www.productinfo.schneider-electric.com/powertagdesigncommguide/powertag-design-comm-guide/EN/BM_PowerTag%20Design%20and%20Comm%20Guide_0000468594.xml/$/Introduction_PowerTagSystemREF_0000468600

Modbus TCP

- A data communication protocol published by Modicon (Schneider electric) in 1979 to be used in an industrial environment
- Devices communicate as master-slave components in Modbus which only one device (master/client) initiates transactions.
- Any device can be a client or server
- Uses memory registers to monitor and control power tags on the network- You should refer to manufacturer register maps
- Uses big-endian representation such that most significant byte is sent first for data larger than a byte
- Uses TCP port 502



https://www.daviteq.com/blog/en/modbus-protocol-and-its-applications-in-iot/

Power tag link gateway registers

- The address of register number n is n-1. For example, the address of register number 3000 is 0x0BB7 (2999).

Current Metering Data

Address	Register	No.	RW	X	Unit	Type	Range	Invalid Value	Svd	Function Code	Applicable Devices	Description
0x0BB7	3000	2	R	–	A	Float32	–	0xFF-C00000	N	03, 100–4	A/M/R	RMS current on phase A
0x0BB9	3002	2	R	–	A	Float32	–	0xFF-C00000	N	03, 100–4	A/M/R	RMS current on phase B
0x0BBB	3004	2	R	–	A	Float32	–	0xFF-C00000	N	03, 100–4	A/M/R	RMS current on phase C
0x0BBD	3006	2	R	–	A	Float32	–	0xFF-C00000	N	03, 100–4	R	RMS current on Neutral

https://download.schneider-electric.com/files?p_enDocType=User+guide&p_File_Name=DOCA0157EN-06.pdf&p_Doc_Ref=DOCA0157EN

Power tag link gateway registers

Voltage Metering Data

Address	Register	No.	RW	X	Unit	Type	Range	Invalid Value	Svd	Function Code	Applicable Devices	Description
0x0BCB	3020	2	R	–	V	Float32	–	0xFF-C00000	N	03, 100–4	A/M/R	RMS phase-to-phase voltage A-B
0x0BCD	3022	2	R	–	V	Float32	–	0xFF-C00000	N	03, 100–4	A/M/R	RMS phase-to-phase voltage B-C

Frequency Metering Data

Address	Register	No.	RW	X	Unit	Type	Range	Invalid Value	Svd	Function Code	Applicable Devices	Description
0x0C25	3110	2	R	–	Hz	Float32	–	0xFF-C0000-0	N	03, 100–4	M/R	AC frequency

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Power tag link gateway registers

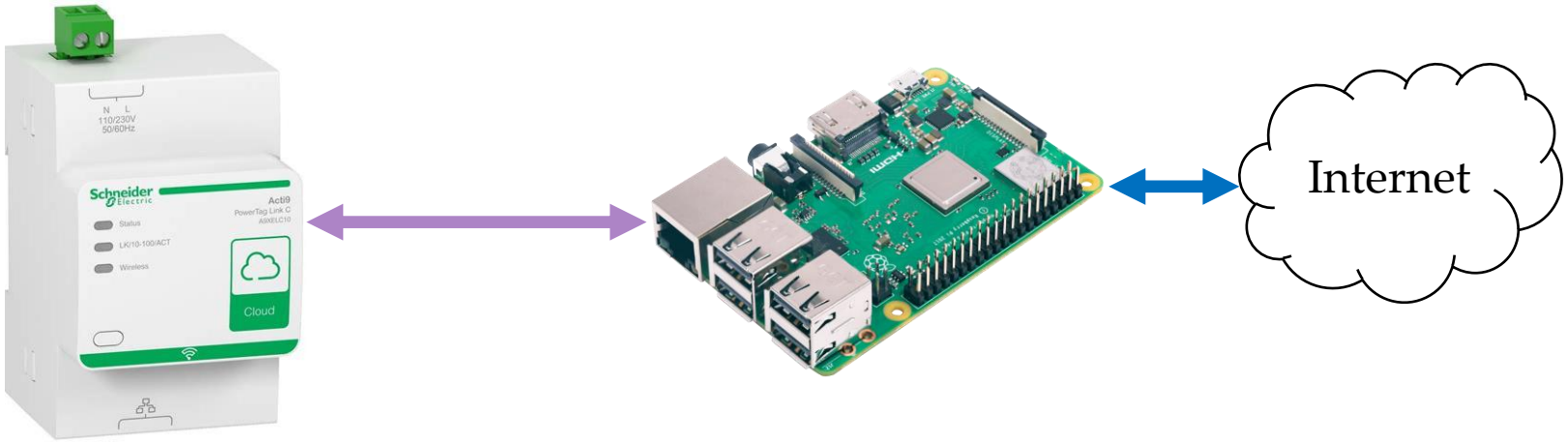
Power Metering Data

Address	Register	No.	RW	X	Unit	Type	Range	Invalid Value	Svd	Function Code	Applicable Devices	Description
0x0BED	3054	2	R	–	W	Float32	–	0xFF-C00000	N	03, 100–4	A/M/R	Active power on phase A
0x0BEF	3056	2	R	–	W	Float32	–	0xFF-C00000	N	03, 100–4	A/M/R	Active power on phase B
0x0BF1	3058	2	R	–	W	Float32	–	0xFF-C00000	N	03, 100–4	A/M/R	Active power on phase C
0x0BF3	3060	2	R	–	W	Float32	–	0xFF-C00000	N	03, 100–4	A/M/R	total active power
0x0BF5	3062	2	R	–	VAR	Float32	–	0xFF-C00000	N	03, 100–4	R	Reactive power on phase A
0x0BF7	3064	2	R	–	VAR	Float32	–	0xFF-C00000	N	03, 100–4	R	Reactive power on phase B
0x0BF9	3066	2	R	–	VAR	Float32	–	0xFF-C00000	N	03, 100–4	R	Reactive power on phase C
0x0BFB	3068	2	R	-	Var	Float32	-	0xFF-C00000	N	03, 100–4	M/R	Total reactive power

https://download.schneider-electric.com/files?p_enDocType=User+guide&p_File_Name=DOCA0157EN-06.pdf&p_Doc_Ref=DOCA0157EN

Power tag reading demo

- Reading Voltage and current of power tag installed in ITS building.



Single board Computers

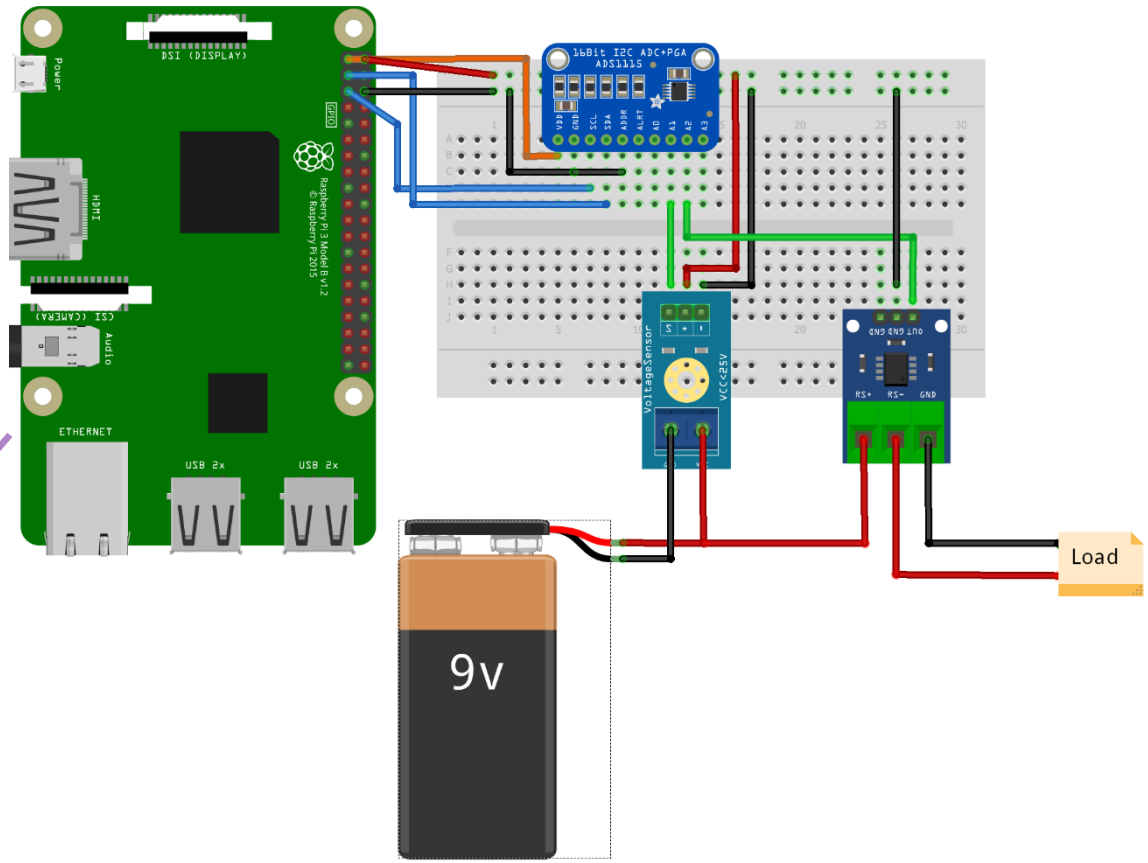
Board name	Clock speed	Processor	Memory	Radio	Dimension	Price
Asus tinker	1.8 GHz	64bit RK3288	2GB DDR3	Wi-Fi Bluetooth	3.37″*2.125″	60 $
Banana Pi M2 Berry	1 GHz	32bit Quad-core Cortex A7	1 GB DDR3	Wi-Fi Bluetooth	3.6″*2.4″	36 $
BeagleBone black	1 GHz	32bit AM335X ARM Cortex-A7	4GB eMMC	-	3.4″*2.1″	55 $
LattePanda	1.92 GHZ	64bit Intel CherryTrail	2GB/4GB	Wi-Fi Bluetooth	2.75″*3.42″	129/159 $
Nvidia Jetson TX2 Dev Kit	2 GHz	64bit ARM V8	8GB DDR4	Wi-Fi Bluetooth	6.7″*6.7″	599 $
Onion Omega2	580 MHz	32bit MIPS	128 MB	Wi-Fi	1.1″*1.7″	5 $
Qualcomm DragonBoard 410c	1.2 GHz	64bit Snapdragon 410	1 GB DDR3 8GB Flash	Wi-Fi Bluetooth	2.12″*3.35″	75 $
Raspberry Pi B+	1.4 GHz	64bit Broadcom BCM2837B0	1 GB DDR2	Wi-Fi Bluetooth	3.4″*2.2″	35 $
Raspberry Pi zero W	1 GHz	32bit Broadcom	microsd	Wi-Fi Bluetooth	1.18″*2.56″	20 $
Samsung Artik 10	1 GHz	32bit quad core Cortex A15	2GB 16GB flash	Wi-Fi Bluetooth	6.3″*4.13″	150 $
Orange Pi plus 2E	1.3 GHz	32bit Quad core	2GB DDR3/, 16GB flash	Wi-Fi	5″*4″	60 $
Arduino zero (Microcontroller)	48 MHz	32-bit ATSAMD21G18	256 K flash	-	2.7″*2.1″	50 $

Raspberry Pi 3 B+

- The Pi 3 Model B+ technical specifications :
  - Broadcom BCM2837B0 chipset
  - 1.4GHz 64bit Quad-Core ARM Cortex-A53, 4 cores
  - 1GB DDR2 RAM
  - 4 USB 2.0 ports (via LAN7515)
  - Gigabit Ethernet (via LAN7515, max speed 300Mbps)
  - PoE (power over Ethernet)
  - 40 pin header (26 GPIOs)
  - MicroUSB power connector (5V, 2.5 A)
  - Dual-band (2.4GHz and 5GHz) 802.11ac Wireless LAN and Bluetooth 4.1 (Bluetooth Classic and LE)
  - HDMI
  - CSI camera interface
  - DSI connector for official screen
  - 3.5mm jack connector supporting stereo audio
  - 2-pin reset header
  - Micro SD socket for storage
  - Raspbian OS (Linux)

Raspberry Pi Demo

- Battery Voltage and Current monitoring
- Required components:
  1. Raspberry Pi 3 B+
  2. ADS1115
  3. Voltage sensor
  4. MAX471 current sensor
  5. Jumper wires
  6. Breadboard



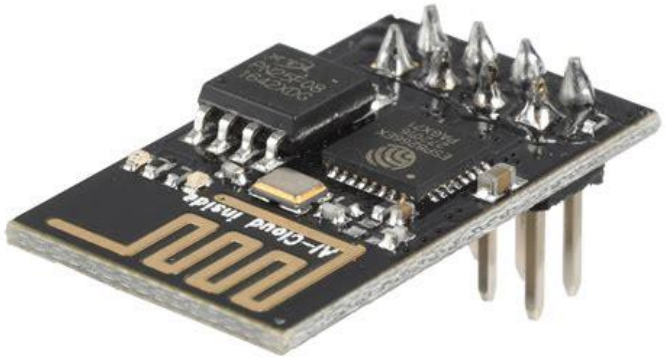
TEK5110 monitoring Platform

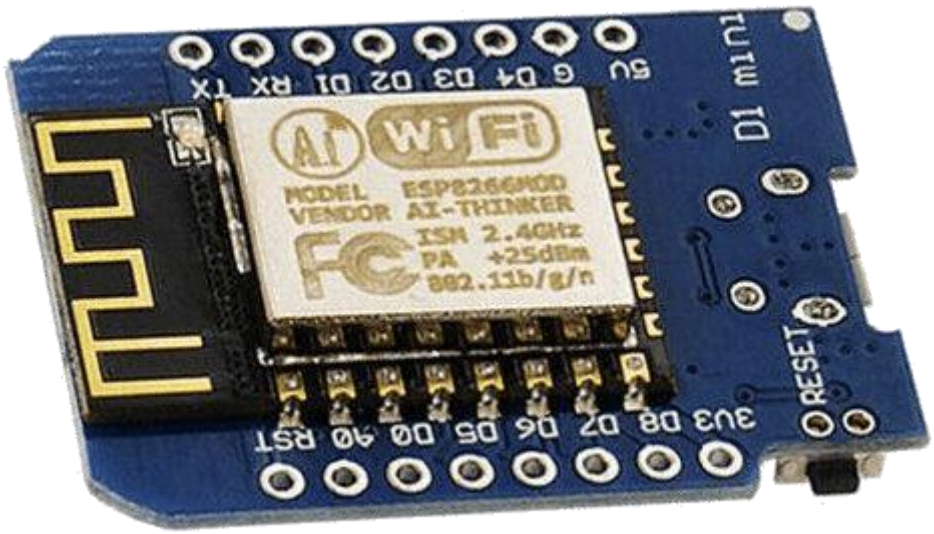
Monitoring BasicInternet infrastructure with Raspberry Pi

- Monitor BasicInternet solar powered Internet for all Wi-Fi hotspot with Raspberry Pi
  - Battery Voltage
  - Current
  - Temperature
  - Humidity

ESP8266

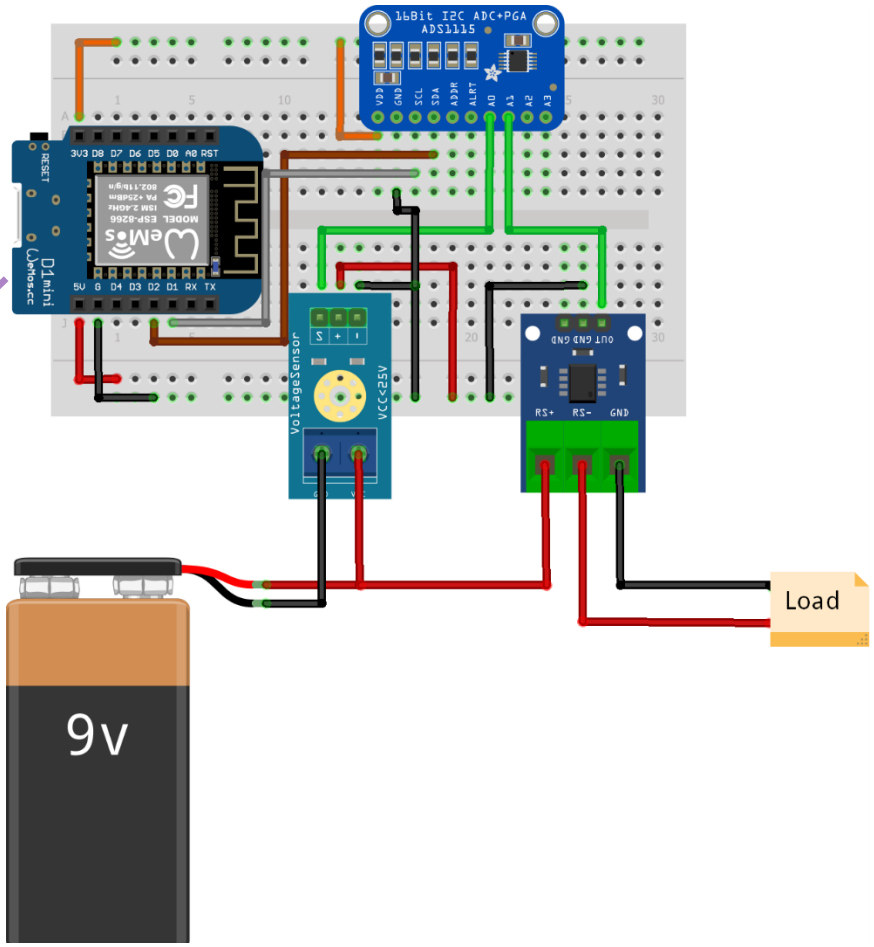
- Low-cost Wi-Fi microchip (30 Kr)
- IEEE 802.11 b/g/n
- Full TCP/IP stack
- Memory:
  - 32 KiB instruction RAM
  - 32 KiB instruction cache RAM
  - 80 KiB user-data RAM
  - 16 KiB ETS system-data RAM
- 10-bit ADC





ESP8266 Demo

- Battery Voltage and Current monitoring
- Required components:
  1. WeMos D1 mini
  2. ADS1115
  3. Voltage sensor
  4. MAX471 current sensor
  5. Jumper wires
  6. Breadboard



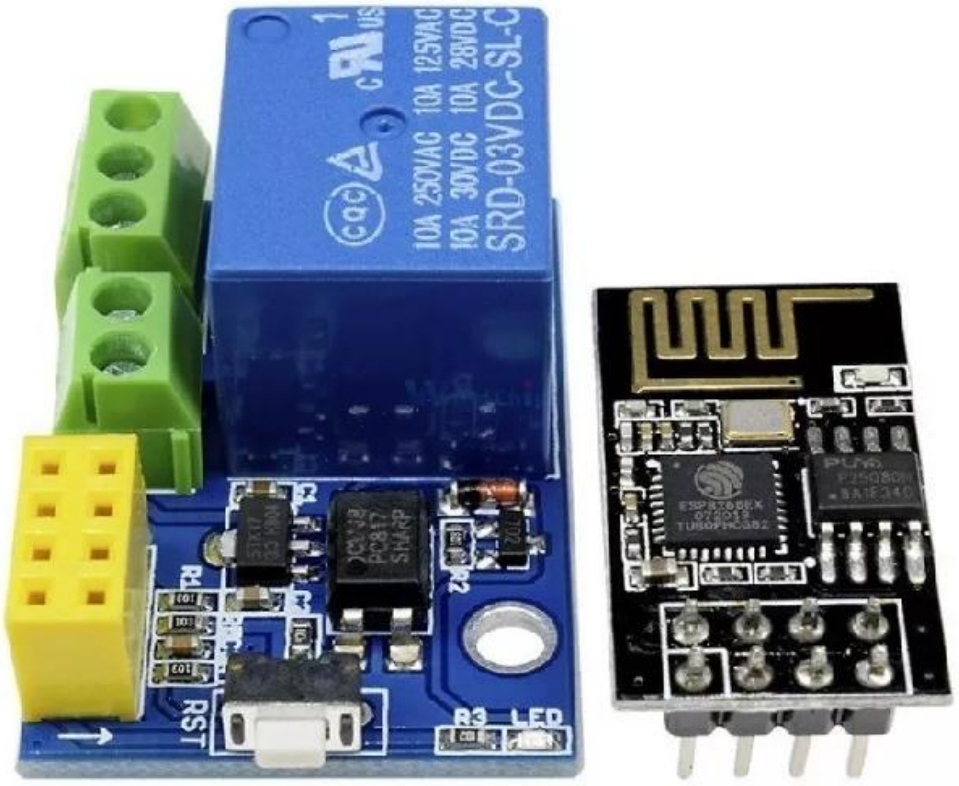
TEK5110 monitoring Platform

ESP8266 Demo

- Temperature and humidity monitoring
- Required components:
  1. DHT11
  2. ESP8266

ESP8266 Demo

- AC/DC wireless switch
- Required components:
  1. Relay
  2. ESP8266



Discussion

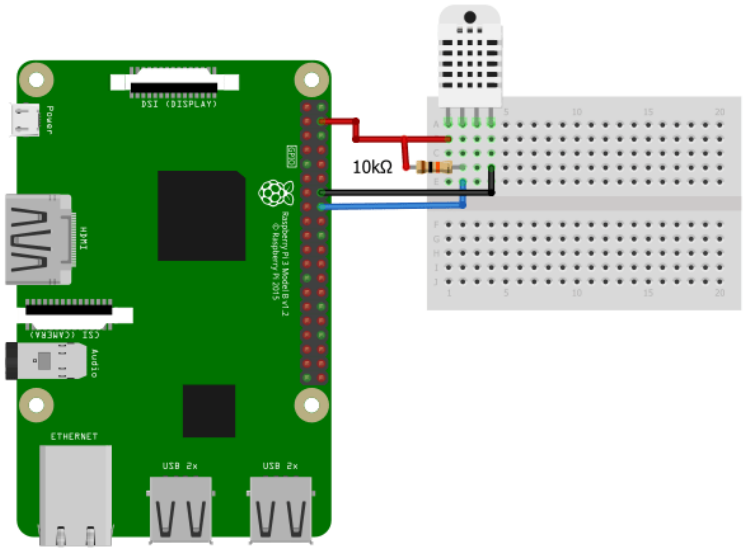
- Why should we monitor and manage IoT?
- What would be optimal monitoring time intervals for IoT?
- What would be optimal IoT management architecture (using gateway or direct connection)?
- Which approach will you use for IoT management in your infrastructure? (configuration management, SDN, open standard protocols or enterprise cloud platforms)
- What are the IoT management security and privacy consideration?

Raspberry Pi Exercise

- Monitoring temperature and humidity project

- Required components:
  1. Raspberry Pi 3 B+
  2. DHT22 temperature and humidity sensor
  3. 10K pullup resistor
  4. Jumper wires
  5. Create an account in ThingSpeak

- Use documentation in ITS-wiki for step by step guide building project



https://electronicshobbyists.com/raspberry-pi-sending-data-to-thingspeak-simplest-raspberry-pi-iot-project//


Q&A