IoT Workshop

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What is IoT

What is IoT

- ▶ Not "a computer connected to the internet"
  - ▶ Then it is really just another computer connected to the internet
- ▶ Must be something else
  - ▶ It is simply devices that are resource constrained
    - ▶ Usually in more than one way
- ▶ Autonomous operation, the connection might not be permanent

IoT is just a concept

▶ *The Internet of Things (IoT) is the network of physical devices, vehicles, home appliances and other items embedded with electronics, software, sensors, actuators, and connectivity which enables these objects to connect and exchange data.*[1]

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[1]Wikipedia "Internet of Things"

What is an IoT Device?

What is an IoT Device?

- Constrained in (one or more of):
    - Memory
    - CPU
    - Network bandwidth and/or latency
    - Storage

Typical IoT chips - Bluetooth 4/5

Chip	CPU	Freq	RAM	Flash	Price
nRF52810	Cortex-M4	64 M	Hz 24k	192k	$1.88
High perf	ormance,	entry	-level Bl	uetooth	4/ANT/2.4GHz SoC

nRF52832 Cortex-M4F 32k 256k $2.54 64k 512k $2.59 High performance Bluetooth 4/ANT/2.4GHz SoC

nRF52840 Cortex-M4F 256k 1024k $3.85 Advanced multi-protocol System-on-Chip Supporting: Bluetooth 5, ANT/ANT+, 802.15.4 and 2.4GHz proprietary

Typical IoT chips - Wi-Fi

Chip	CPU	Freq	ROM	RAM	Price
ESP8266	Tensilica L106	160 MHz	N/A	~50 kB	< $1

ESP32 - dual cpu, Wi-Fi, Bluetooth 4 ESP32-D0WDQ6 2x Xtensa @ 160MHz $ 4.53 @ 10

State	Current usage
Off	0.5 µA
Deep sleep with RTC	20 µA
Light sleep (with Wi-Fi)	1 mA
Sleep with peripherials	15 mA
TX	170 mA

ESP8266 details - Arduino

https://github.com/esp8266/Arduino

Going back to basics

What is the internet again?

OSI model

1. Physical Layer
2. Data Link Layer
3. Network Layer
4. Transport Layer
5. Session Layer
6. Presentation Layer
7. Application Layer

▶ Wikipedia: OSI model
▶ Wikipedia: OSI model#Examples

Layer 1: Physical Layer

- ▶ 10BASE5, 10BASE2
- ▶ 10BASE-T / 100BASE-TX / 1000BASE-TX
- ▶ 802.11a/b/g/n PHY
- ▶ RS-232

Layer 2: Data Link Layer

- Ethernet
- WiFi
- Bluetooth
- Token Ring

Layer 3: Network Layer

- IP
- ICMP
- IPX

Layer 4: Transport Layer

- TCP
- UDP

Layer 5: Session Layer

- "sockets"
- NetBIOS

# Layer 6: Presentation Layer

- SSL

Layer 7: Application Layer

- HTTP
- DNS
- MQTT
- CoAP
- (everything else..)

Details: IP

Details: IP

bit	0	7	8	15	16	31
0	version	len	TOS		full length of packet	
4	identification			X D M	fragment Offset	
8	time to live (TTL)		protocol		header checksum	
12	source IP address					
16	destination IP address					
20	IP options (variable length)					
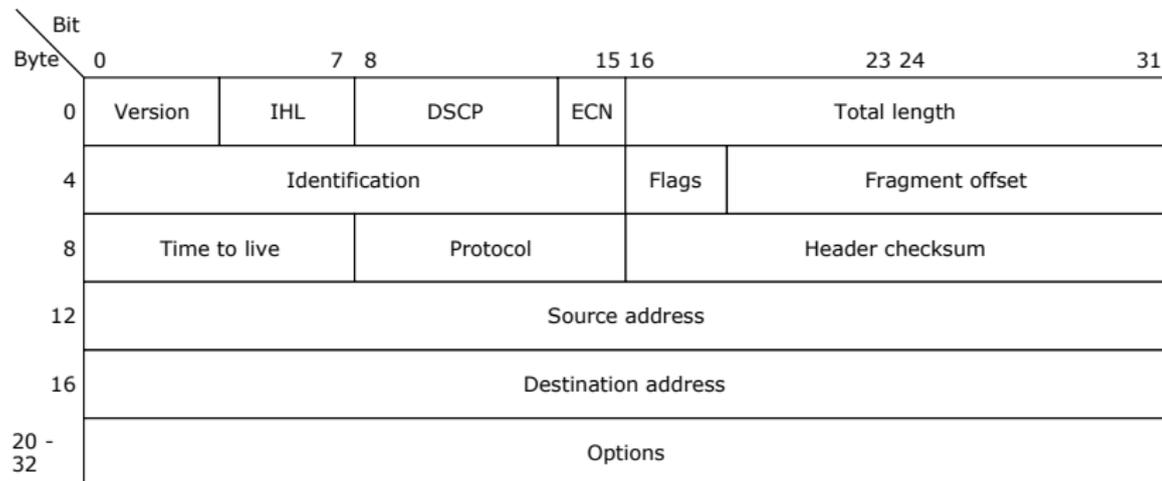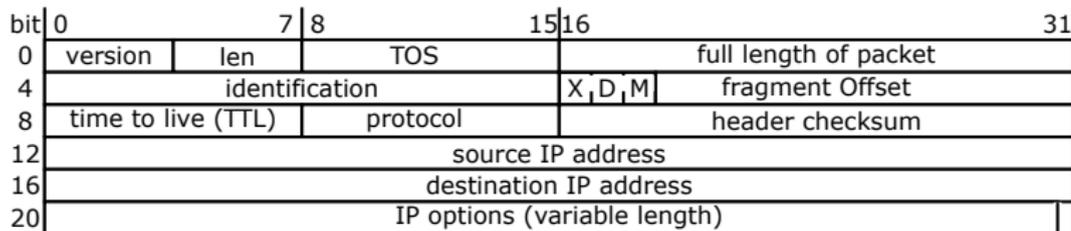
Lecture: ESP8266 aka NodeMCU aka ESP-12

Lecture: MQTT

MQTT

▶ *Message Queuing Telemetry Transport*
▶ Wikipedia: MQTT

MQTT Implementations

- Mosquitto
- Eclipse Paho
- Redis with MQTT connector

MQTT Cloud Connectors

- ▶ Cloud
  - ▶ Amazon IoT
  - ▶ Google Cloud IoT
  - ▶ Microsoft Azure IoT
  - ▶ CloudMQTT
- ▶ DIY
  - ▶ ThingMQ
  - ▶ HiveMQ

Notes

Assignments

▶ Measure round trip time/latency. Measure UDP, TCP. Measure when the packet size is greater than the MTU

▶ Measure ISR timing