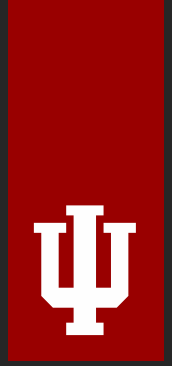


E210 Engineering Cyber-Physical Systems (Spring 2021)

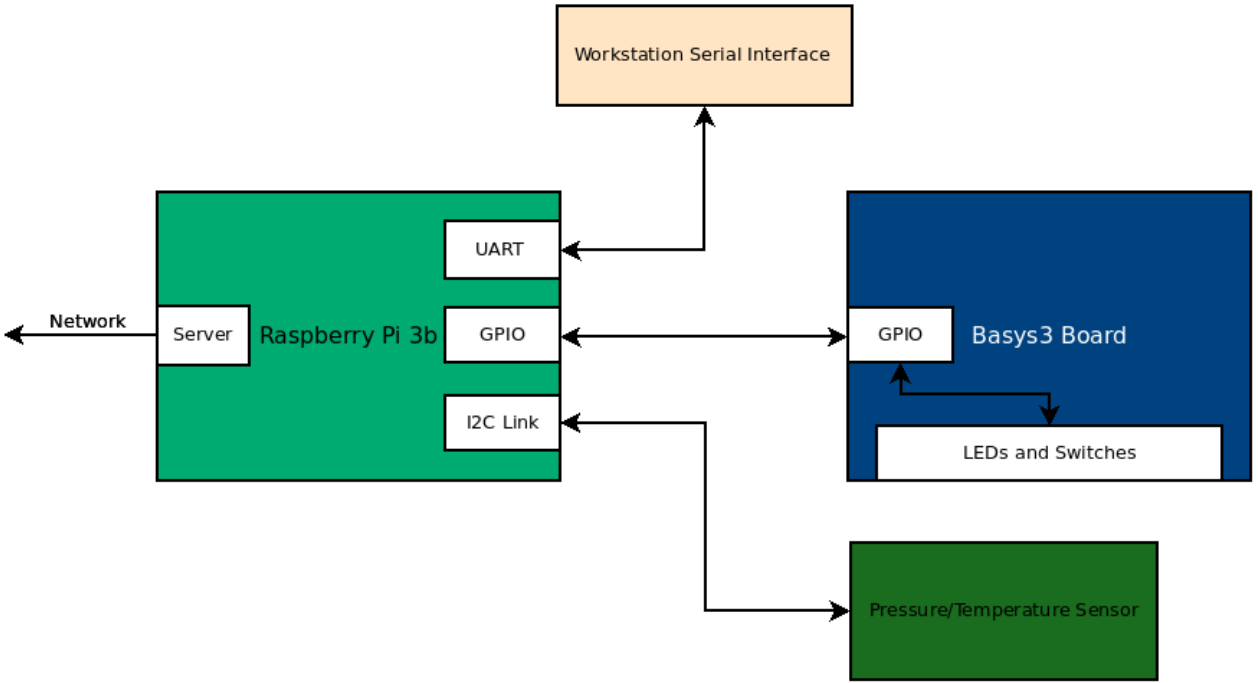
Networking Overview

Bryce Himebaugh

Weekly Focus	Reading	Monday	Wed	Lab
Exam/CPS Introduction	Ref 1 Chapter 1	**3/8:** Exam 1	**3/10:** CPS Introduction	**Project 5 Raspberry PI Setup**
Raspberry Pi	Ref 2 Chapter 1-3	**3/15:** Pi Intro/UART Bus	**3/17:** Git/Github	
I2C Bus	Ref 3	**3/22:** I2C Bus	**3/24:** Wellness Day	**Project 6 I2C Pressure Sensor**
Python/Sensor	Ref 4, Ref 5	**3/29:** Classes/Modules	**3/31:** Pressure Sensor	
SPI	Ref 6	**4/5:** SPI Bus Overview	**4/7:** SPI HDL Design	**Project 7 SPI Connected I/O**
SPI	Ref 7 Chapter 1	**4/12:** SPI HDL Design	4/14: IOT Overview	
Network Interface	Ref 7 Chapter 2	**4/19:** Ethernet Interface	**4/21:** MQTT	**Project 8 Network Interface**
MQTT/Flask	Ref 7 Chapter 14	**4/26:** Flask	**4/29:** Open Topic	

https://engr210.github.io/

Raspberry PI/Basys3 Link

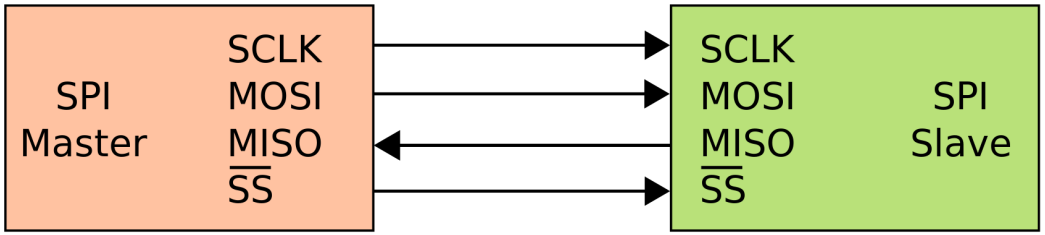


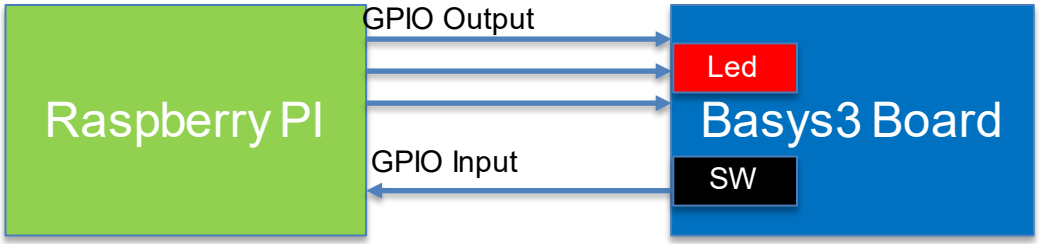
Lab 7 Adjustments

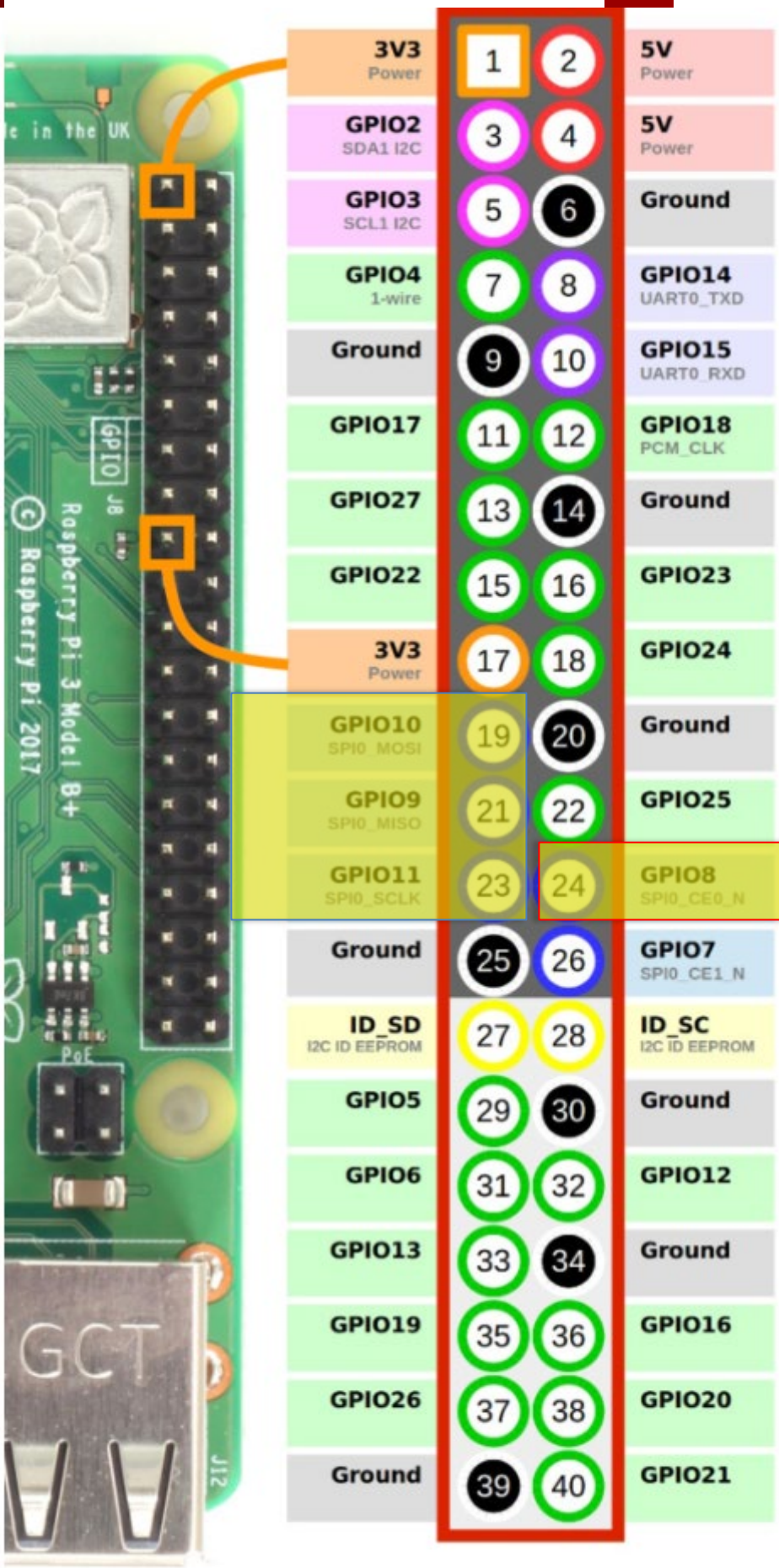
1. Late Release
2. Simplified
   - GPIO vs. SPI
3. Original Due Date Extended

Lab 7 Hardware Adjustments

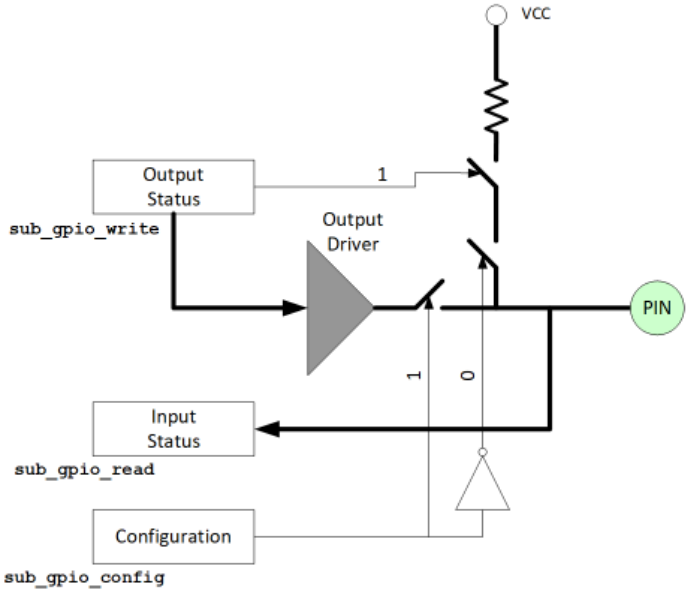
From SPI to GPIO

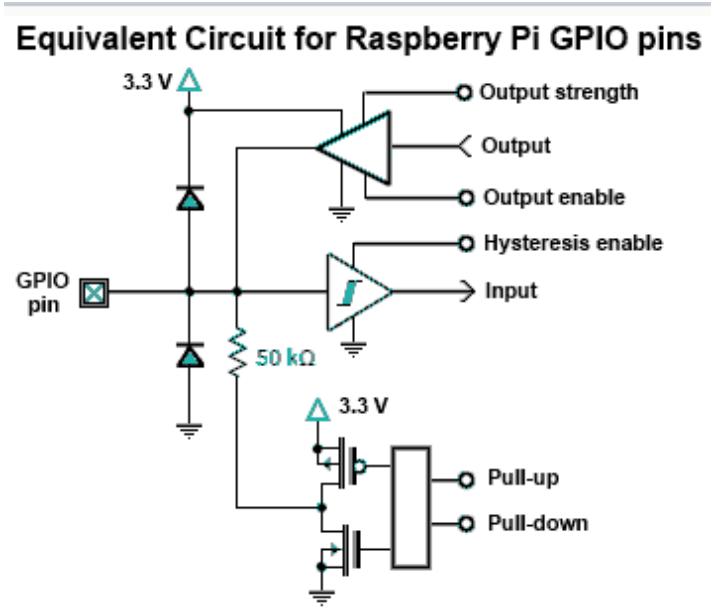


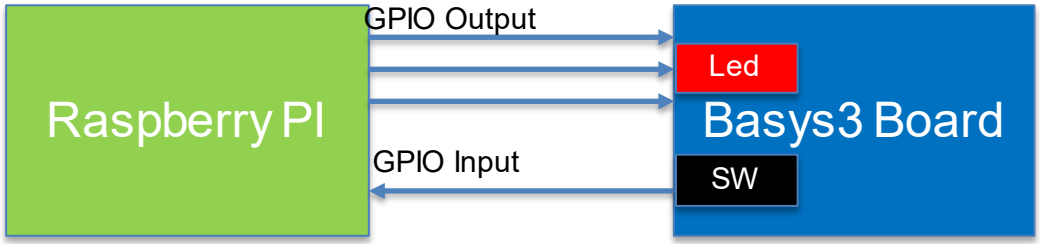


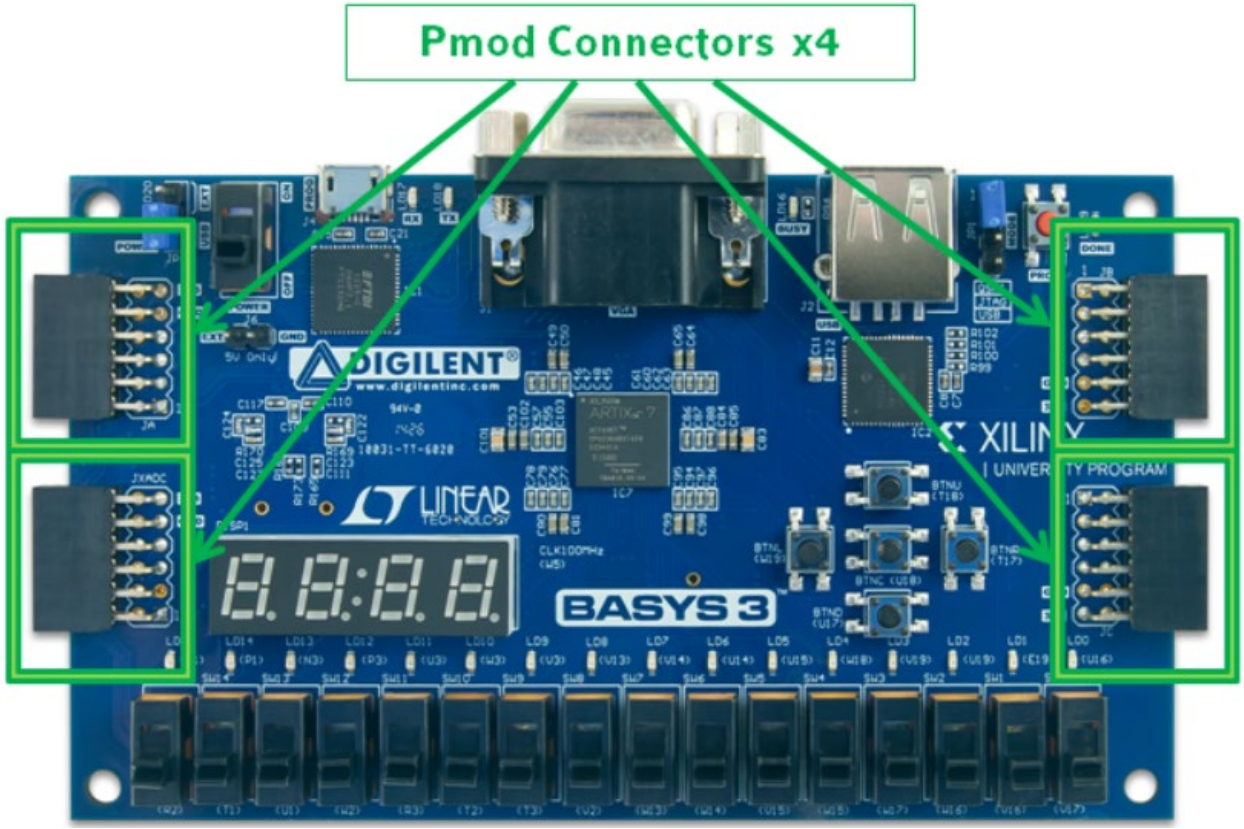

3V3 Power
1
2
5V Power
GPIO2 SDA1 I2C
3
4
5V Power
GPIO3 SCL1 I2C
5
6
Ground
GPIO4 1-wire
7
8
GPIO14 UART0_TXD
Ground
9
10
GPIO15 UART0_RXD
GPIO17
11
12
GPIO18 PCM_CLK
GPIO27
13
14
Ground
GPIO22
15
16
GPIO23
3V3 Power
17
18
GPIO24
GPIO10 SPI0_MOSI
19
20
Ground
GPIO9 SPI0_MISO
21
22
GPIO25
GPIO11 SPI0_SCLK
23
24
GPIO8 SPI0_CE0_N
Ground
25
26
GPIO7 SPI0_CE1_N
ID_SD I2C ID EEPROM
27
28
ID_SC I2C ID EEPROM
GPIO5
29
30
Ground
GPIO6
31
32
GPIO12
GPIO13
33
34
Ground
GPIO19
35
36
GPIO16
GPIO26
37
38
GPIO20
Ground
39
40
GPIO21
GPIO
J8
Raspberry Pi 3 Model B+
Raspberry Pi 2017
PoE
GCT
J12

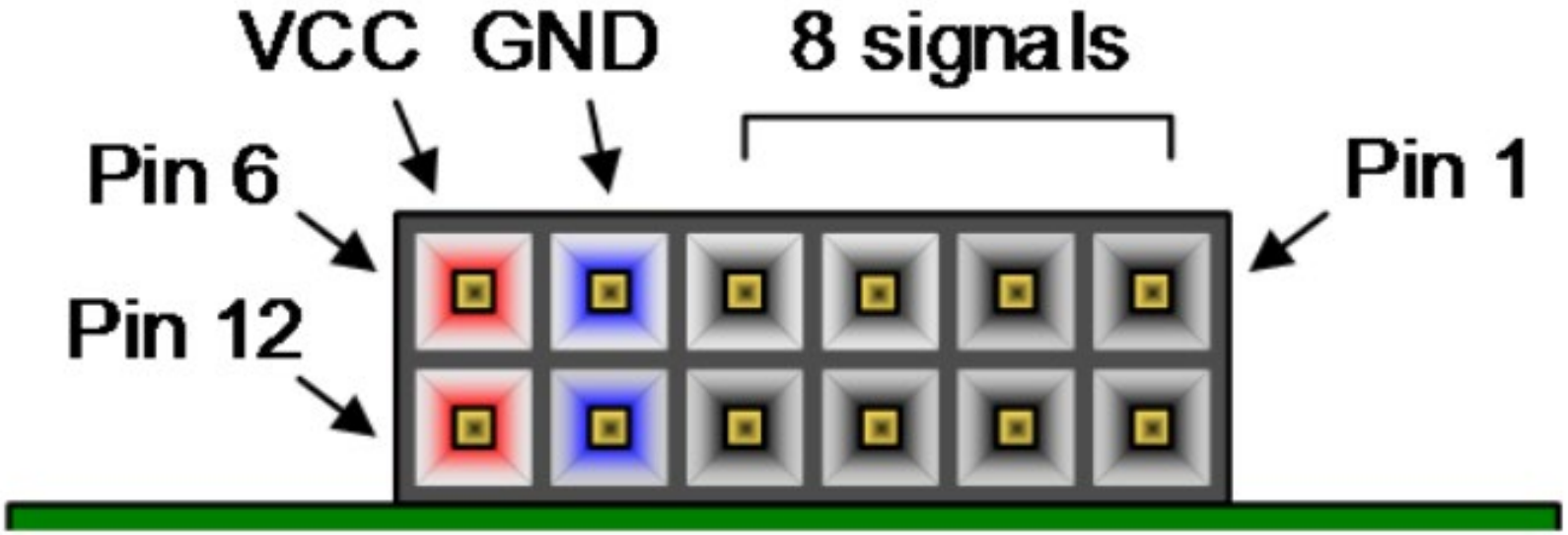
GPIO Structure






Raspberry PI
GPIO Output
GPIO Input
Led
SW
Basys3 Board

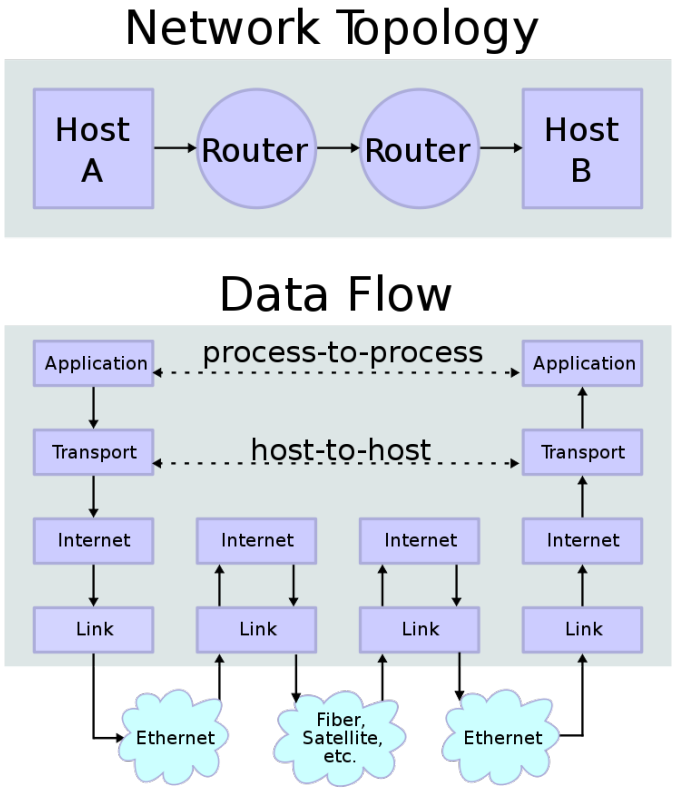

Pmod Connectors x4
DIGILENT
www.digilentinc.com
LINEAR TECHNOLOGY
BASYS 3


VCC
GND
8 signals
Pin 6
Pin 1
Pin 12

Networking Overview

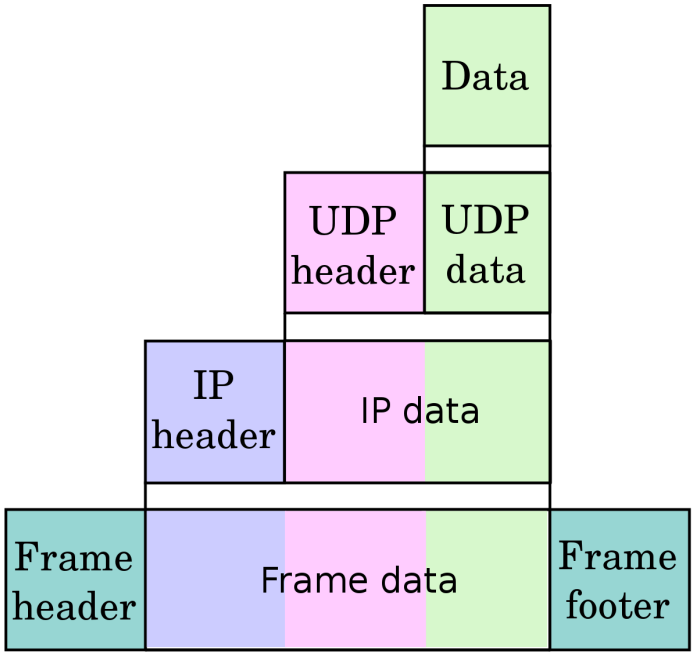
Networking

1. Communication Protocol
2. End-to-End data communication



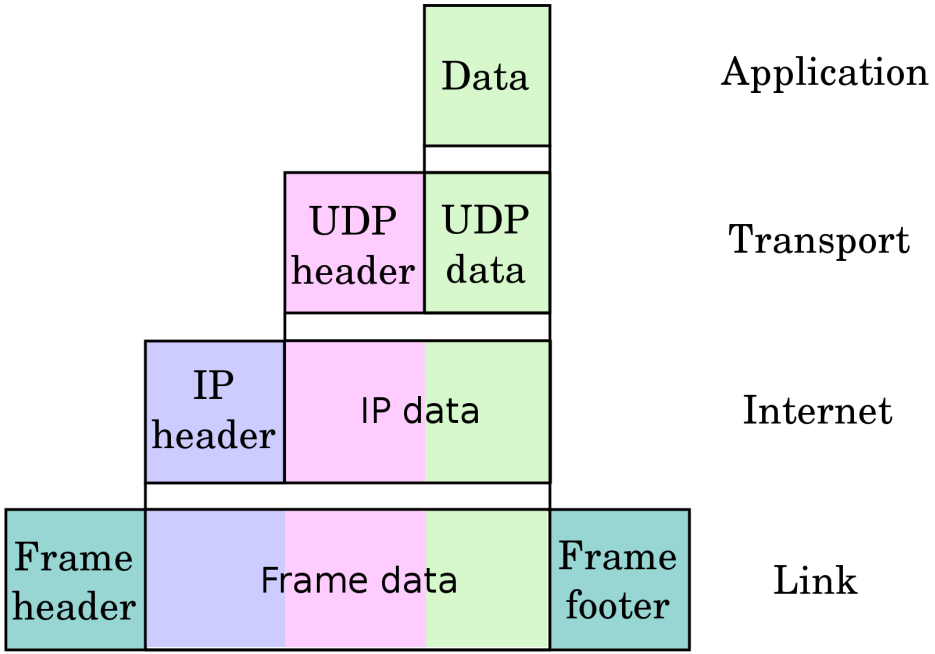
Networking

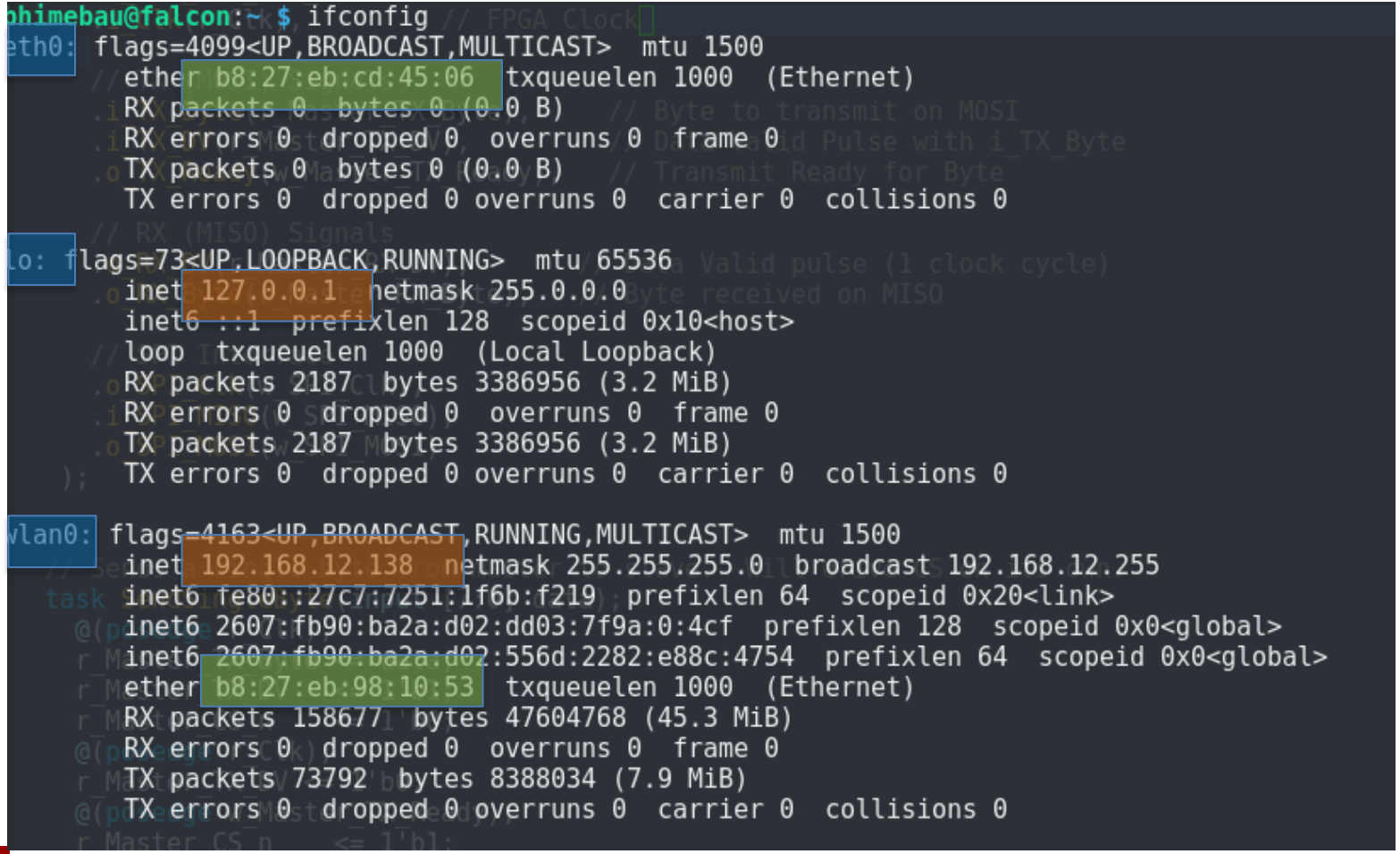
1. Application Layer
   - SSH
   - HTTP
2. Transport Layer
   - (TCP) Transmit Control Protocol
   - (UDP) User Datagram Protocol



Networking

1. Internet
   - IP Address
   - Defines Routing Structures
2. Link
   - Defines local network segment
   - MAC HW Address




hhimebau@falcon:~ $ ifconfig
eth0: flags=4099<UP,BROADCAST,MULTICAST> mtu 1500
ether b8:27:eb:cd:45:06 txqueuelen 1000 (Ethernet)
RX packets 0 bytes 0 (0.0 B)
RX errors 0 dropped 0 overruns 0 frame 0
TX packets 0 bytes 0 (0.0 B)
TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0
lo: flags=73<UP,LOOPBACK,RUNNING> mtu 65536
inet 127.0.0.1 netmask 255.0.0.0
inet6 ::1 prefixlen 128 scopeid 0x10<host>
loop txqueuelen 1000 (Local Loopback)
RX packets 2187 bytes 3386956 (3.2 MiB)
RX errors 0 dropped 0 overruns 0 frame 0
TX packets 2187 bytes 3386956 (3.2 MiB)
TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0
wlan0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
inet 192.168.12.138 netmask 255.255.255.0 broadcast 192.168.12.255
inet6 fe80::27c7:7251:1f6b:f219 prefixlen 64 scopeid 0x20<link>
inet6 2607:fb90:ba2a:d02:dd03:7f9a:0:4cf prefixlen 128 scopeid 0x0<global>
inet6 2607:fb90:ba2a:d02:556d:2282:e88c:4754 prefixlen 64 scopeid 0x0<global>
ether b8:27:eb:98:10:53 txqueuelen 1000 (Ethernet)
RX packets 158677 bytes 47604768 (45.3 MiB)
RX errors 0 dropped 0 overruns 0 frame 0
TX packets 73792 bytes 8388034 (7.9 MiB)
TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

Ports

1. Multiple Services on Same IP Address.
2. TCP/UDP
3. 16-bit unsigned integer
4. Assigned by Internet Assign Numbers Authority
   - (IANA https://www.iana.org/)

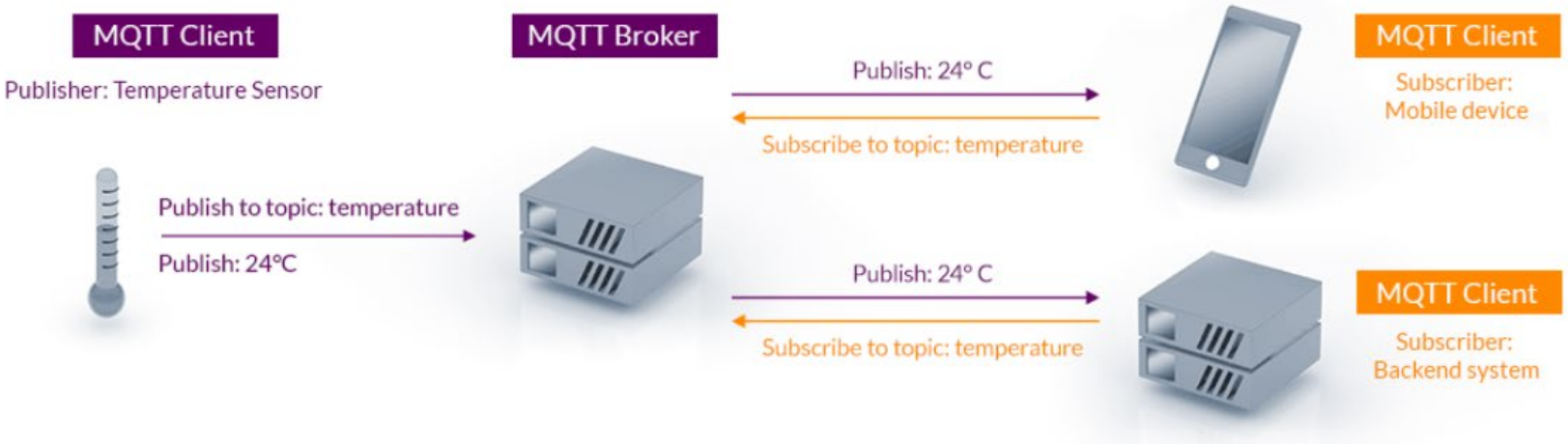
Notable well-known port numbers

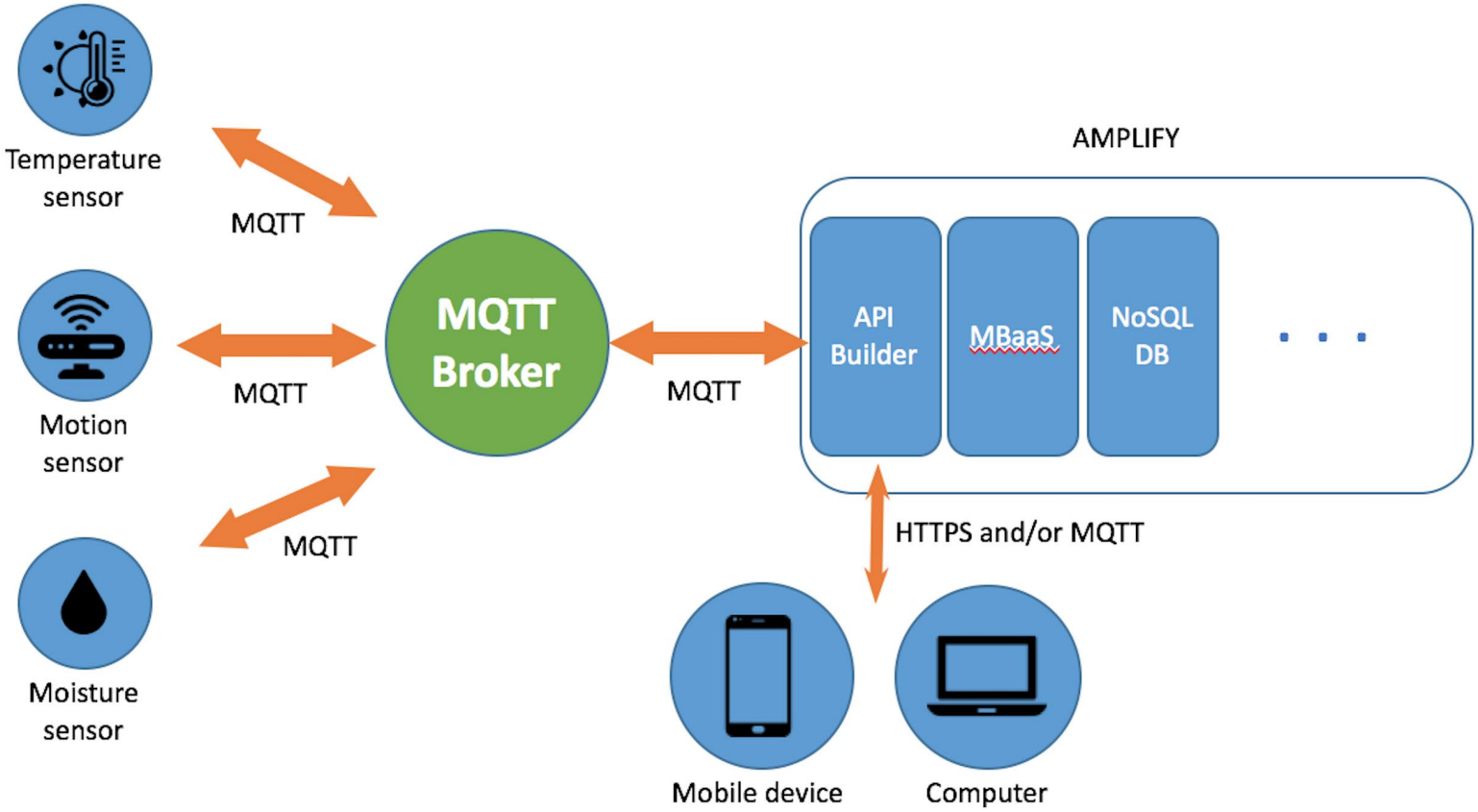
Number	Assignment
20	File Transfer Protocol (FTP) Data Transfer
21	File Transfer Protocol (FTP) Command Control
22	Secure Shell (SSH) Secure Login
23	Telnet remote login service, unencrypted text messages
25	Simple Mail Transfer Protocol (SMTP) E-mail routing
53	Domain Name System (DNS) service
67, 68	Dynamic Host Configuration Protocol (DHCP)
80	Hypertext Transfer Protocol (HTTP) used in the World Wi
110	Post Office Protocol (POP3)
119	Network News Transfer Protocol (NNTP)
123	Network Time Protocol (NTP)
143	Internet Message Access Protocol (IMAP) Management c
161	Simple Network Management Protocol (SNMP)
194	Internet Relay Chat (IRC)
443	HTTP Secure (HTTPS) HTTP over TLS/SSL

Message Queuing Telemetry Transport

MQTT

MQTT (Port 1883, Secure-MQTT 8883)




Temperature sensor
MQTT
Motion sensor
MQTT
MQTT Broker
MQTT
AMPLIFY
API Builder
MBaaS
NoSQL DB
. . .
Moisture sensor
MQTT
HTTPS and/or MQTT
Mobile device
Computer

Mosquitto

1. Open-source Implementation of MQTT Protocol
2. Broker/Clients
3. Bindings for many languages including Python and C.
4. Managed by Eclipse Foundation
5. Demo …

Flask

Flask

1. Python Micro Web Framework
   - Opposite approach to Django Framework
2. Developed as an April Fool's joke in 2004
3. Hammer vs toolbox …

```python
from flask import Flask
app = Flask(__name__)

@app.route("/")
def hello():
    return "Hello World"


if __name__ == "__main__":
    app.run(debug=False)
```