

Jan Schmidt

# Building a Heterogeneous IoT Testbed

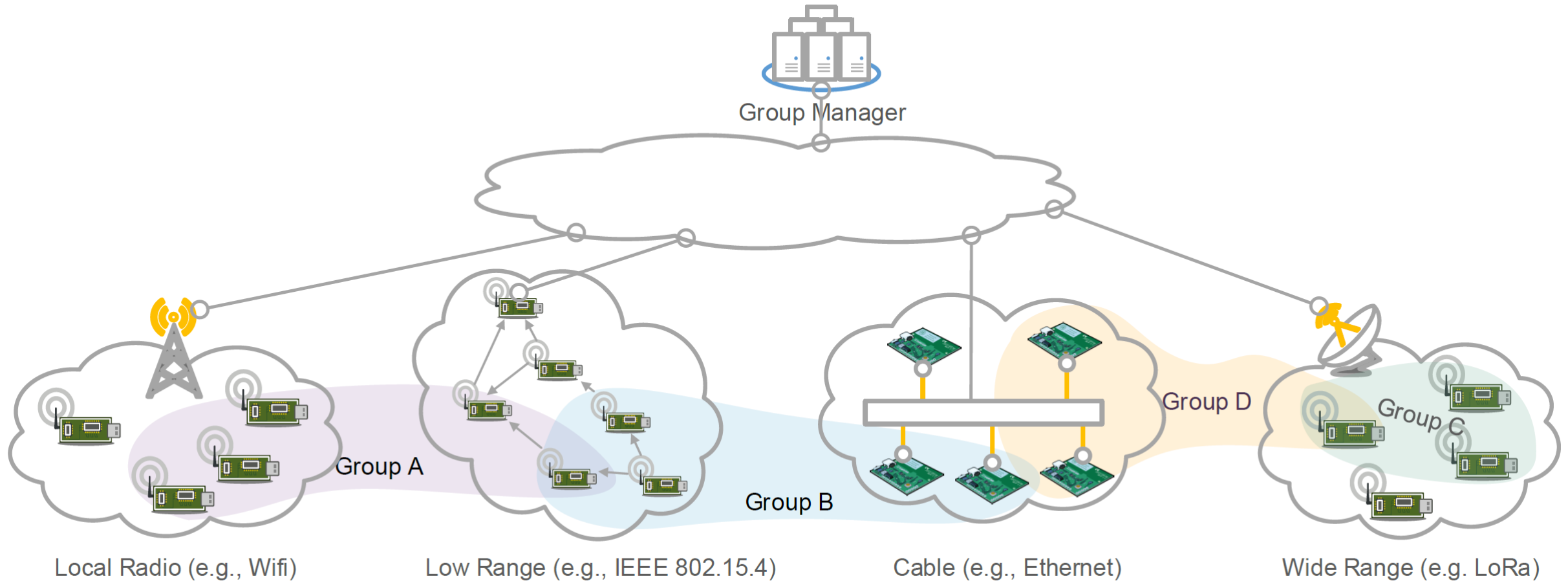
## The Good, the Bad and the Ugly

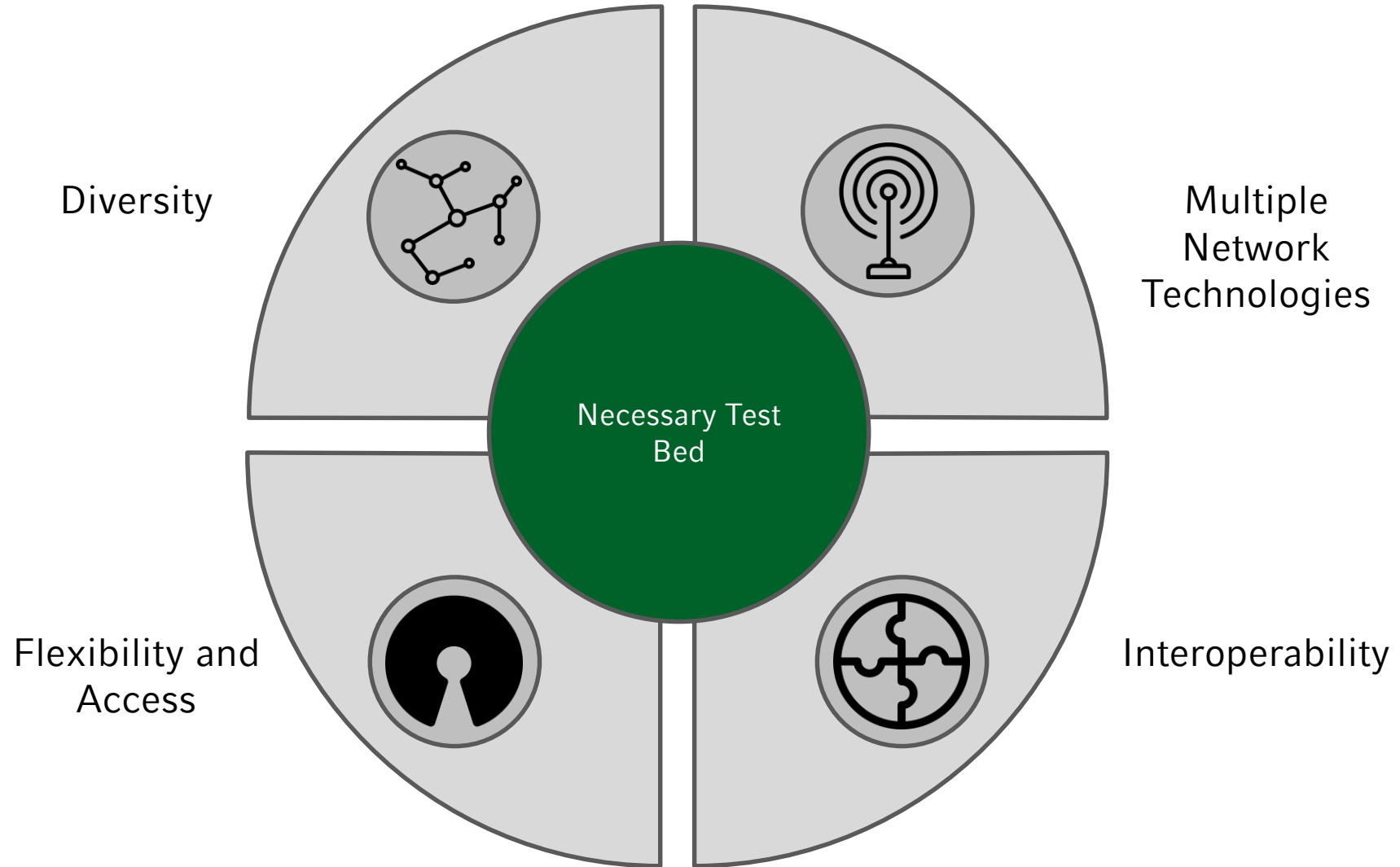
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- LMU Munich
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- 19.02.2020



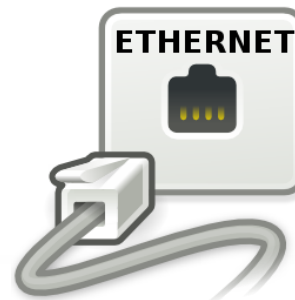


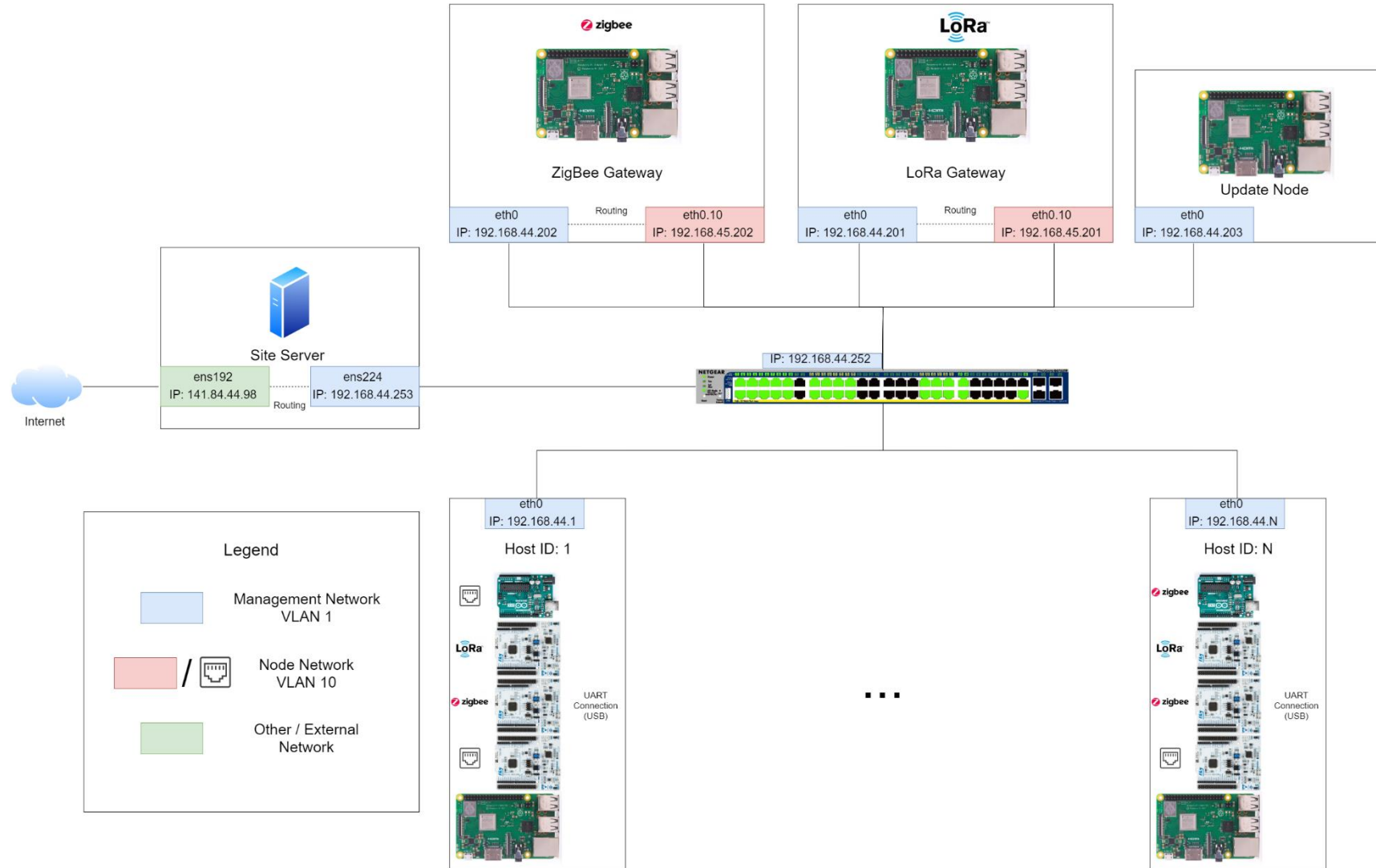






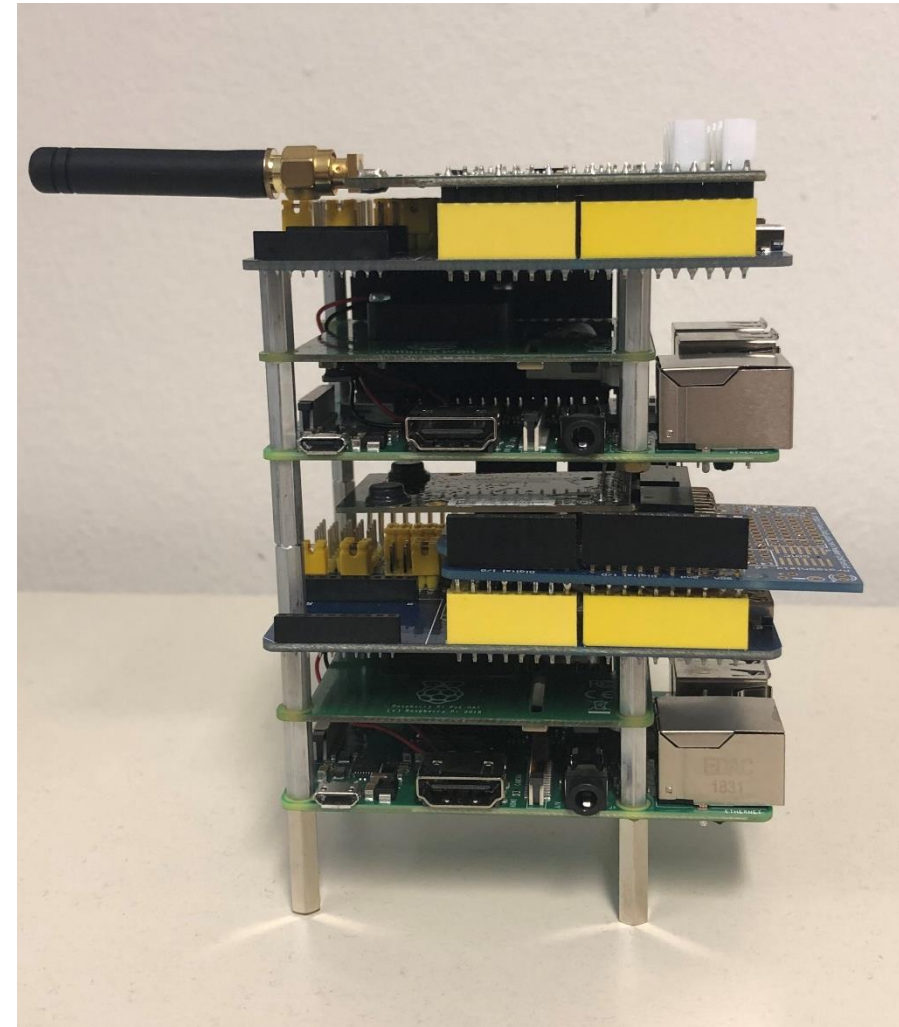
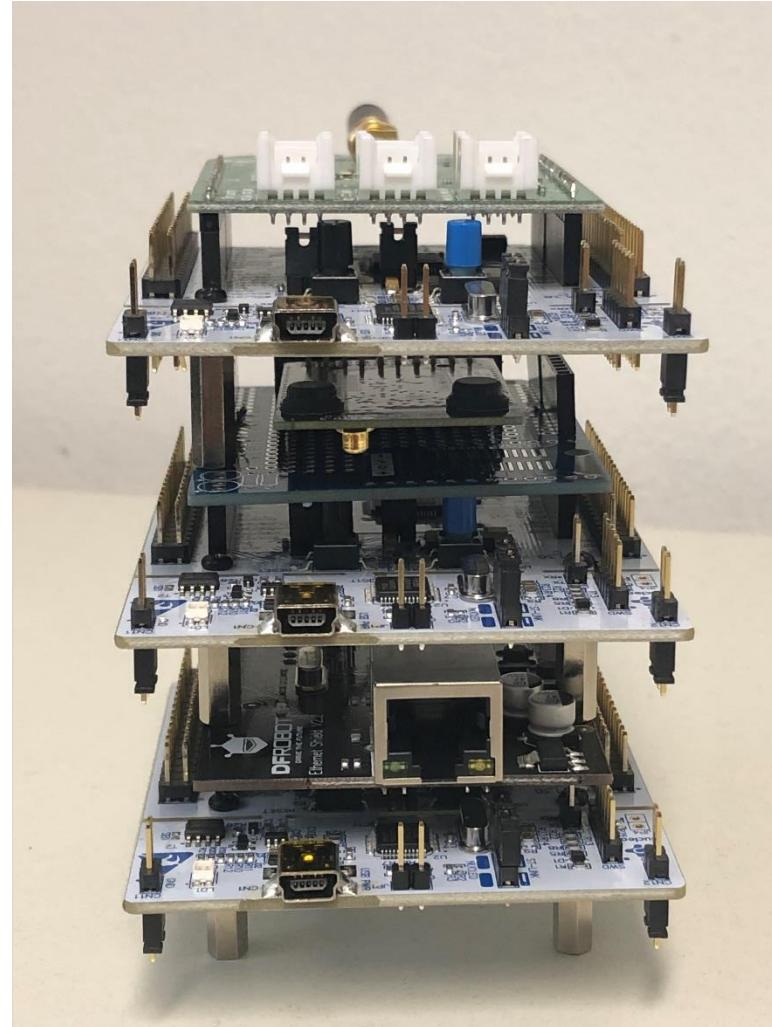
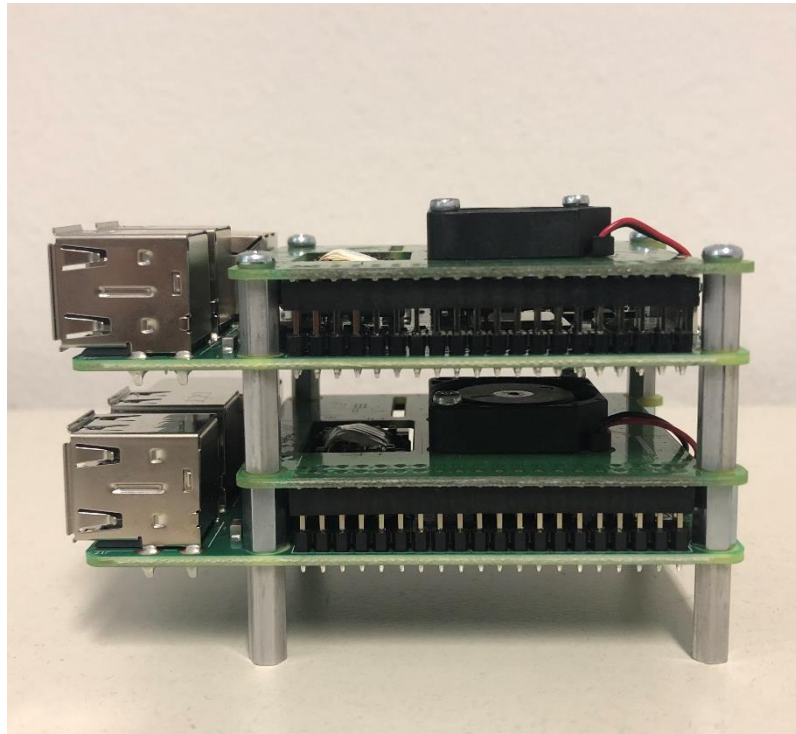
Requirement	RAM	ROM	Processor	Price	Count
Nucleo-F019RC	32 KB	256 KB	ARM Cortex M0	€9.37	6
Nucleo-F103RB	20 KB	128 KB	ARM Cortex M3	€9.37	6
Nucleo-F411RE	96 KB	512 KB	ARM Cortex M4	€11.80	6
Nucleo-F767ZI	512 KB	2 MB	ARM Cortex M7	€20.89	6
Arduino M0 Pro	32 KB	256 KB	ARM Cortex M0	€27.90	6



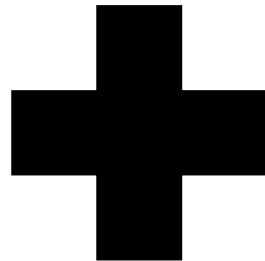
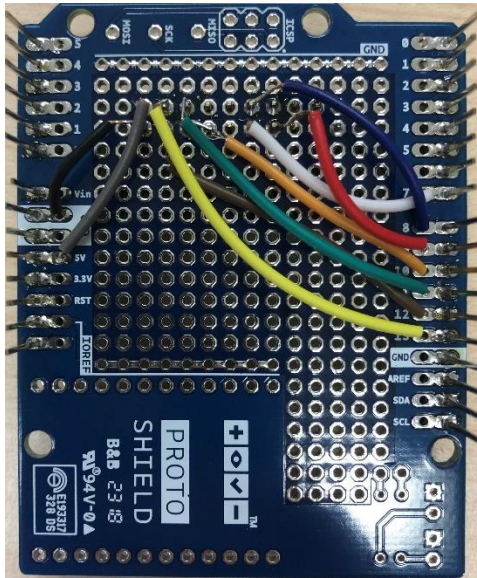
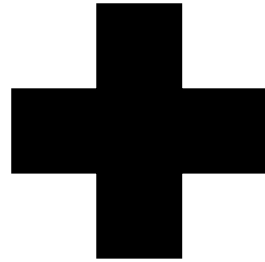




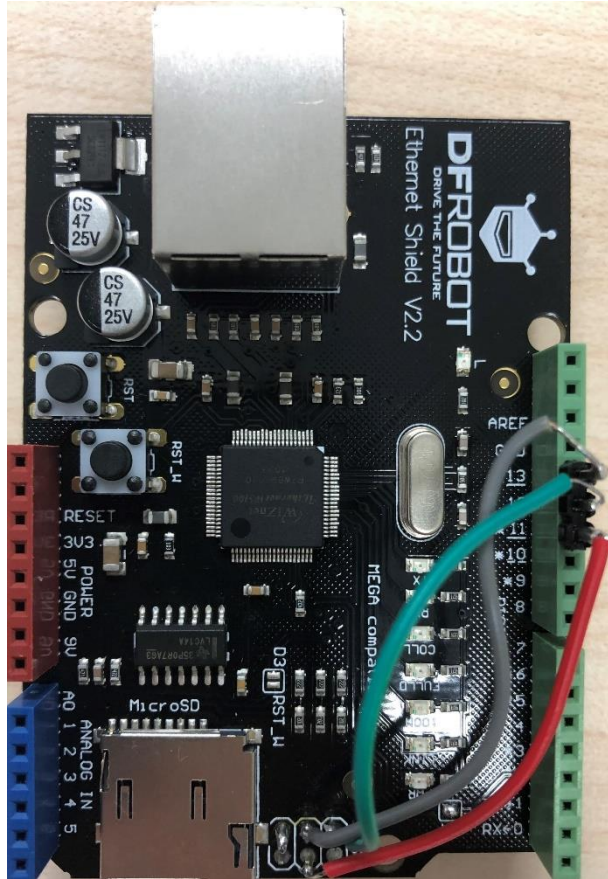




# Shield Compatibility



# Networking Shields



DFRobot Ethernet Shield V2.2



Atmel 802.15.4 / ZigBee Shield w/ Arduino Prototyping Shield



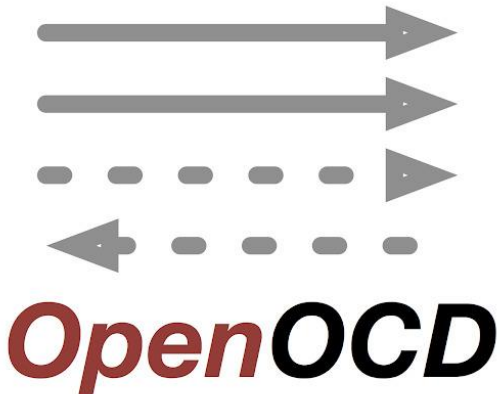
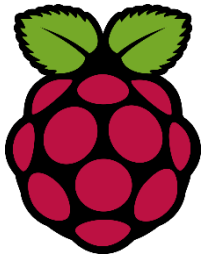
LoRa Semtech SX1272 Shield

# Multiple Nodes per RPi

```
pi@raspberrypi:~ $ ls -l /dev/ttyACM*
crw-rw---- 1 root dialout 166, 0 Feb 11 12:04 /dev/ttyACM0
crw-rw---- 1 root dialout 166, 1 Feb 11 12:04 /dev/ttyACM1
crw-rw---- 1 root dialout 166, 2 Feb 11 12:04 /dev/ttyACM2
crw-rw---- 1 root dialout 166, 3 Feb 11 12:04 /dev/ttyACM3
```

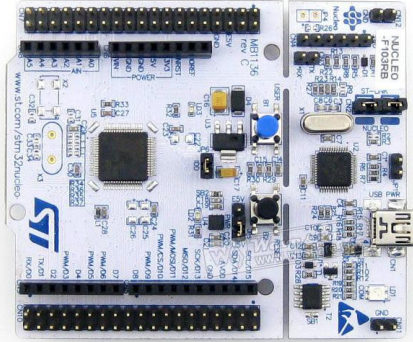


```
pi@raspberrypi:~ $ cat /etc/udev/rules.d/stlink.rules
KERNEL=="ttyACM*",SUBSYSTEM=="tty", SUBSYSTEMS=="usb", PROGRAM="/bin/serial.sh %k", SYMLINK+="iotlab/ttyON_STLINK%c" [...]
```

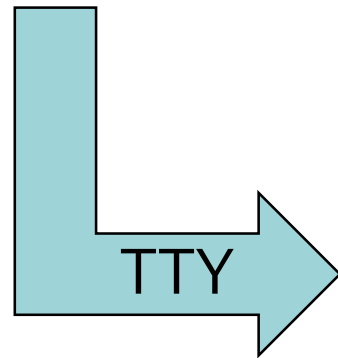


```
pi@raspberrypi:~ $ ls -l /dev/iotlab/
ttyON_CMSIS_DAP -> ../ttyACM3
ttyON_STLINK0669FF504955657867152925 -> ../ttyACM2
ttyON_STLINK066FFF495648807567055626 -> ../ttyACM1
ttyON_STLINK066FFF515055657867193131 -> ../ttyACM0
```

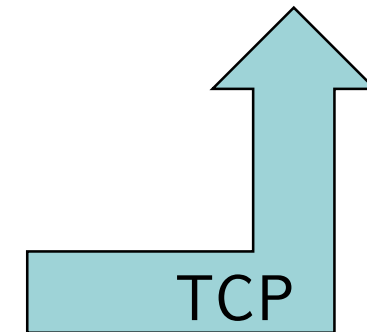
# Serial Redirection

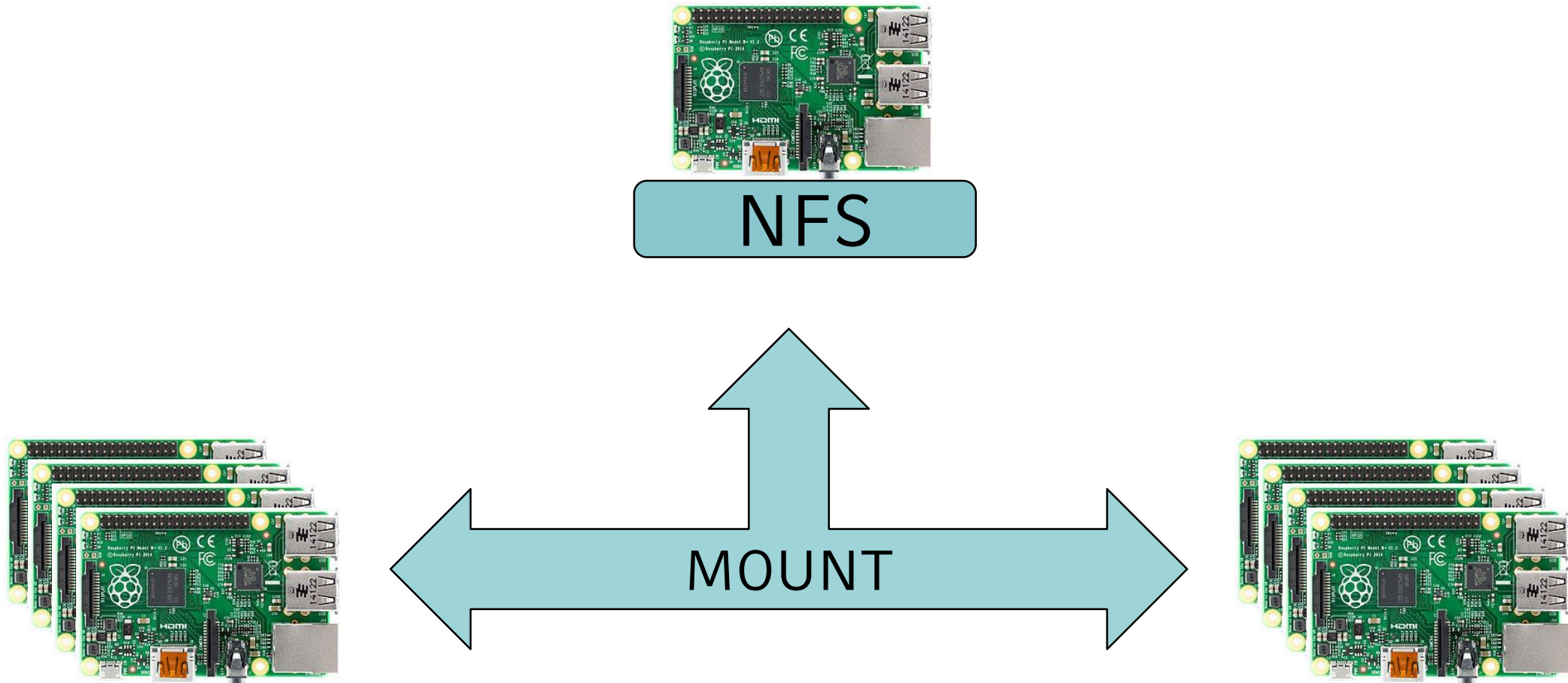


```
/dev/iotlab/ttyON_STLINK0669FF504955657867152925
```



SOCAT





```
1 : st_f411re : Lora
2 : st_f411re : Zigbee
3 : st_f411re : Ethernet
4 : st_f411re : Lora
5 : st_f411re : Zigbee
6 : st_f411re : Ethernet
7 : st_f091rc : Lora
8 : st_f091rc : Zigbee
9 : st_f091rc : Ethernet
10 : st_f091rc : Lora
11 : st_f091rc : Zigbee
12 : st_f091rc : Ethernet
13 : st_f103rb : Lora
14 : st_f103rb : Zigbee
15 : st_f103rb : Ethernet
16 : st_f103rb : Lora
17 : st_f103rb : Zigbee
18 : st_f103rb : Ethernet
19 : arduino_zero : Lora
20 : arduino_zero : Zigbee
21 : arduino_zero : Ethernet
22 : arduino_zero : Ethernet
23 : arduino_zero : Zigbee
24 : st_f767zi : Ethernet
25 : st_f767zi : Ethernet
26 : st_f767zi : Ethernet
27 : st_f767zi : Ethernet
28 : st_f767zi : Ethernet
29 : st_f767zi : Ethernet
```

Choose File st-f767zi\_autotest.elf

Flash

```
ID:1 IP:192.168.44.3
ID:4 Type:st_f411re Serial Port: 25060
ID:5 Type:st_f411re Serial Port: 25061
ID:6 Type:st_f411re Serial Port: 25062
ID:19 Type:arduino_zero Serial Port: 25063
```

```
ID:2 IP:192.168.44.4
ID:27 Type:st_f767zi Serial Port: 25060
ID:28 Type:st_f767zi Serial Port: 25061
ID:29 Type:st_f767zi Serial Port: 25062
```



## The Good

- Flexibility
- Off-The-Shelf
- New Approaches
- It's fun!



## The Bad

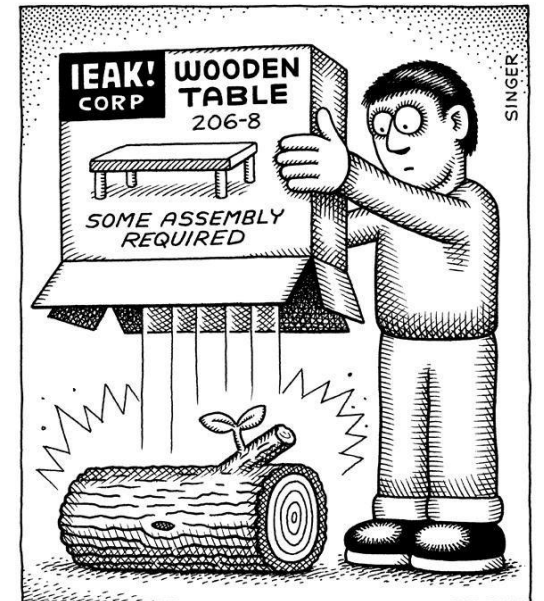
- Compatibility
- Monitoring
- Networking Stacks



## The Ugly

- User Management
- Web Interface
- Soldering Required

NO EXIT © Andy Singer



## The Future

- Improved logging for experiments
- Sandboxing of RPi
- Integration with FIT IoT Lab
- Implementation of better Networking Stacks