Module 3: Building a node

1. Recap from last week
2. Parts of a node
3. Radio frequency
4. Meshing your nodes
5. Building your own node
6. Wrap-up & homework

Recap from last week

First Week

Using Raspberry Pis, we *formed* a wireless mesh network.

Last week

Using Raspberry Pis, we configured a wired network.

This Week

Using Raspberry Pis, we will *configure* a wireless mesh network.

Parts of a node

Single Board Computer

- All the components of a computer on one board

- Components include processors, memory, storage, peripherals

- Smart phone revolution modernized these types of computers

- A node runs our software, processing signals and routing traffic
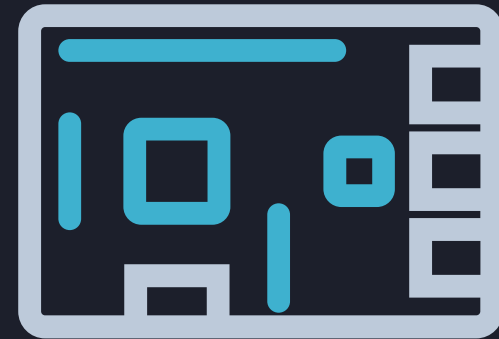
Storage

- Many types of storage, each good for different reasons
- Some properties to be aware of:

    - **Format** - how the physical device works?
    - **Speed** - how fast can it access and store data?
    - **Capacity** - how much data can it store?
    - **Endurance** - how long can it store the data for?

SD

Power supply

- Allow us to power the node

- Consider what power you have available:

  - Wall plug - city's power gird

  - Batteries - stored power from another source

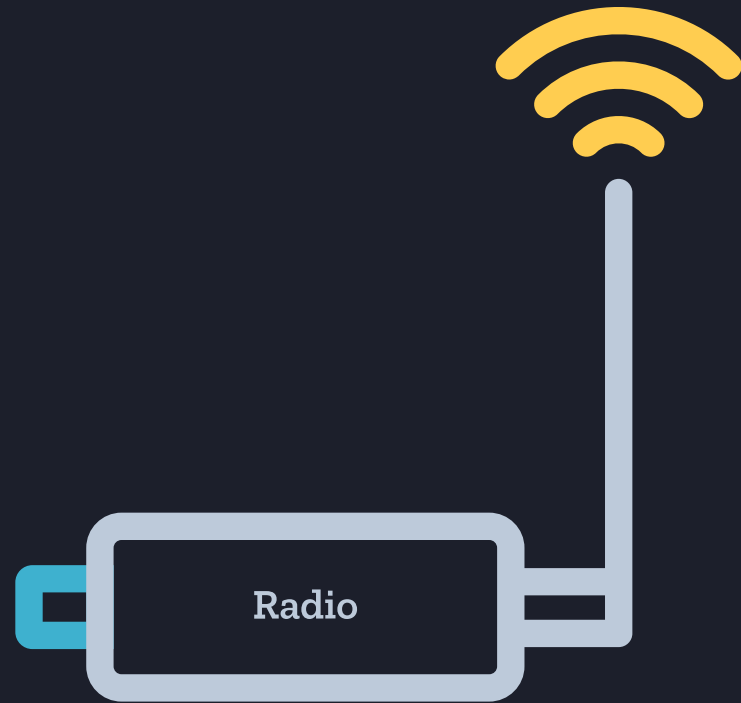 - Solar, wind, etc. - alternative sources

Antenna

- Used to receive (Rx) and transmit (Tx)

- Designed for specific frequency ranges and purposes

Radio

- We use the 802.11 standard known as "WiFi"

- Radios can come in many formats

- They connect to an antenna

Radio

Radio & waves

Radio - the technology of using electromagnetic waves to carry information

Frequency

- Measured in Hertz (Hz), or cycles per second
- We tune the radio to hear other people on the same frequency

Amplitude

- How much power the wave has
- How loud we are talking

Polarity

- Which direction is the wave cycling
- Orientation of the antenna is important

Phase

- The offset of peaks and valleys of two waves
- You add the values at each point to calculate the new amplitude
  - Two peeks or valleys - wave has double the amplitude
  - A peek and a valley - amplitude closer to zero
- Interference happens when waves bounce off walls

Channel width

- Defines how wide of a frequency band does the signal take up
- Larger channel width:

  - Provides more frequencies

  - Allows for more data to be sent at once

  - Is more susceptible to mode noise

Frequencies & channels

Channels - human defined numbers that point to a specific frequency

- There are 13 channels defined for WiFi

- In Canada we can only use the first 11

- First channel starts at 2.412 GHz (or 2,412 MHz)

- The channels are spaced out by 5 MHz

- Standard WiFi signals use a channel width of 20 Mhz

- There are only 3 non-overlapping signals in the 2.4 GHz range (1, 6, and 11)

Licensing

- There are many frequencies coexisting in the air
- Most of them are designated to a specific function
- Government agency tasked with controlling them in Canada is the CRTC
- 2.4 Ghz and 5.0 Ghz do not require any licensing
- Used by many devices, such as microwave ovens, not just WiFi devices
- They look like noise to WiFi devices

Meshing your nodes

Infrastructure mode

Most common setup for WiFi:

- Router acts as an Access Point (AP)

- Each device connects to it to communicate

- Single point of failure, the router

Mesh mode

There are two different modes that we can use to create a mesh:

- Independent Basic Service Set (IBSS)

  - Also known as Ad-hoc

  - Much older and more supported

- Mesh Point (802.11s)

  - A new specification

  - Not many devices support this mode

  - Many useful features

Meshing in Linux

To mesh in Linux you issue the following commands:

- Turn off the interface:

  - `ip link set dev <interface> down`

- Switch to a mesh mode:

  - `iw <interface> set type <mode>`

- Turn on the interface:

  - `ip link set dev <interface> up`

- Join a group at a particular frequency:

  - `iw dev <interface> <mode> join <group name> <frequency>`

- Assign an IP address:

  - `ip addr add <ip address>/24 dev <interface>`

Worksheet

- Break up into pairs
- Configure the two nodes to mesh together
- Assign IP addresses
- Ping each IP address

Building your own node!

Wrap-up & Homework

Homework

Next session we will discuss wireless links more extensively, both theoretically and the practical aspects when configuring a wireless mesh network.

⧉ A quick tour of a mesh networking installation from the Metamesh YouTube channel

Optionally:

- Read Wireless Networking in the Developing World, Chapter 10: Deployment Planning
- Watch How to install a Smartrek wireless mesh network for sugar making purposes (4:31)
- Watch Rural Next Generation Broadband Project (6:12)