

Hudson Valley Digital Network | www.hvdsn.org /presentations

LoRa & HASviolet

About Hudson Valley Digital Network (HVDN)

Subpart A—General Provisions

§ 97.1 Basis and purpose.

The rules and regulations in this part are designed to provide an amateur radio service having a fundamental purpose as expressed in the following principles:

(a) Recognition and enhancement of the value of the amateur service to the public as a voluntary noncommercial communication service, particularly with respect to providing emergency communications.

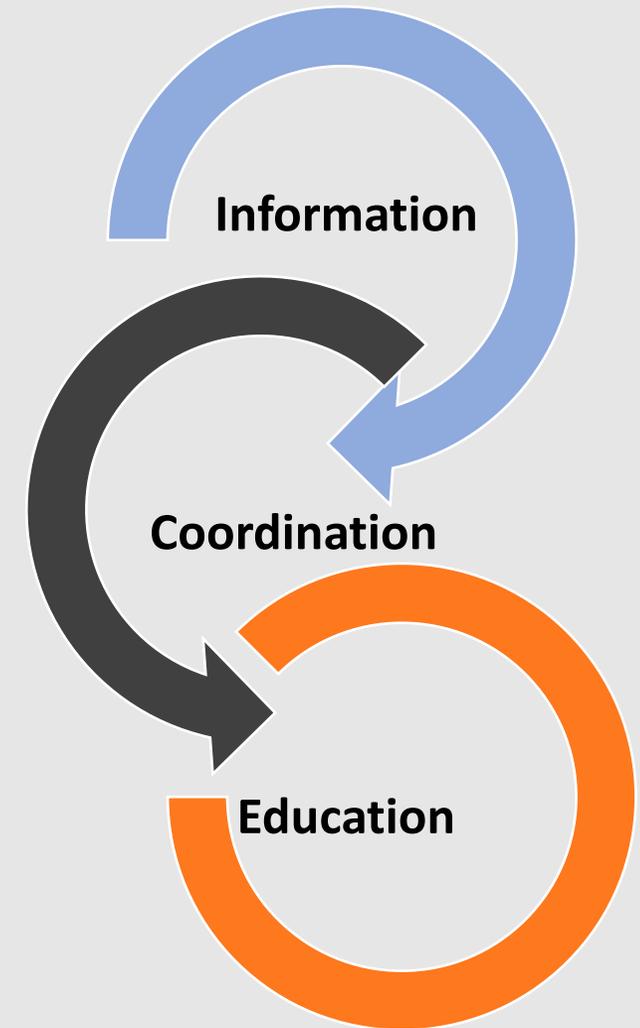
(b) Continuation and extension of the amateur's proven ability to contribute to the advancement of the radio art.

(c) Encouragement and improvement of the amateur service through rules which provide for advancing skills in both the communication and technical phases of the art.

(d) Expansion of the existing reservoir within the amateur radio service of trained operators, technicians, and electronics experts.

(e) Continuation and extension of the amateur's unique ability to enhance international goodwill.

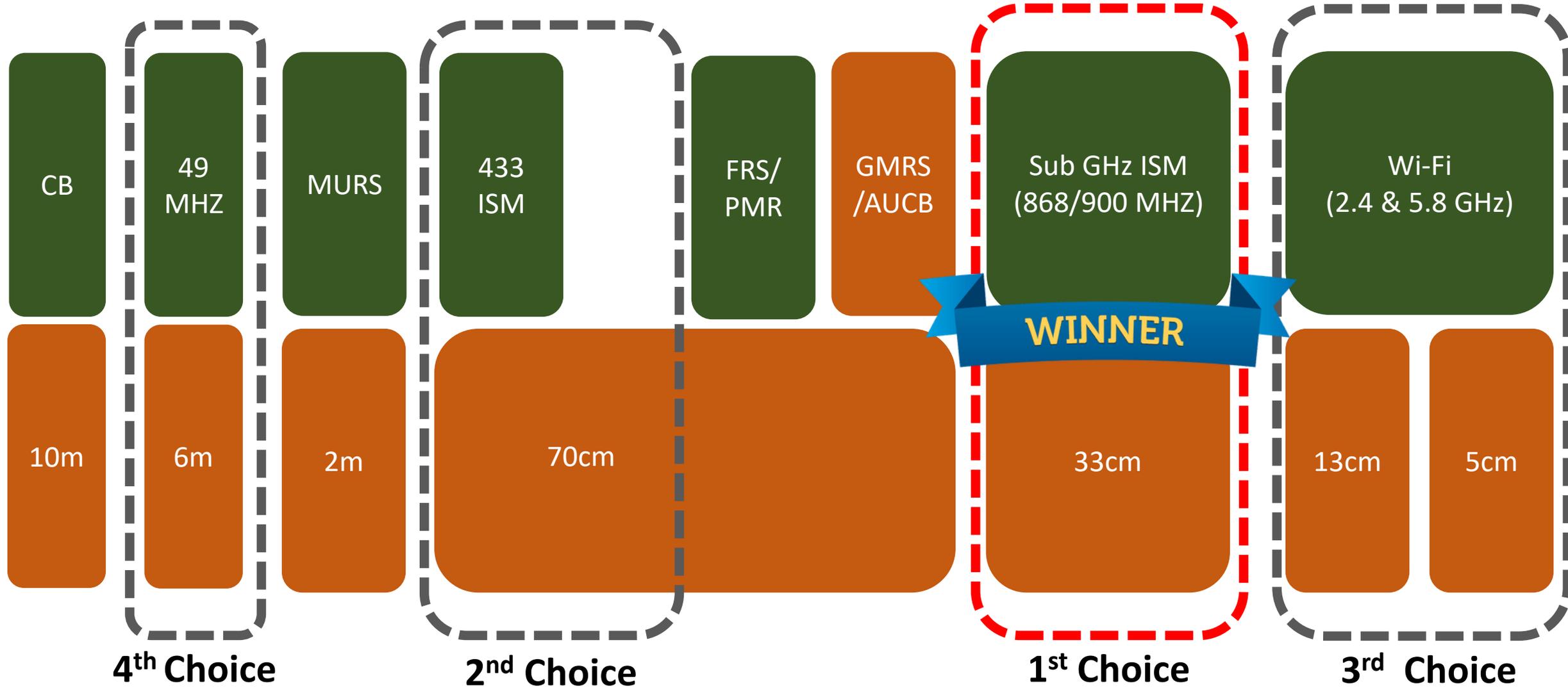
- HVDN founded 2017
- Digital meets physical world
- Deliberate modern & future focus
- Club call sign N2HVD
- Uphold FCC Part 97.1
- 3 pillar approach



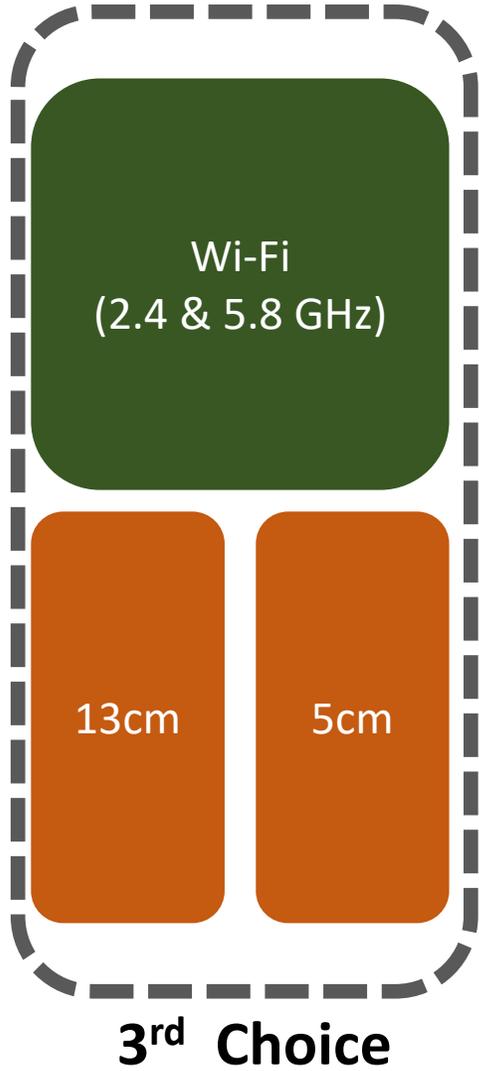
Presentation Goal

Amateur radio lacks the diversity it **may** have once had. The goal of the **HASviolet** project is to inspire more use of spectrum, interesting applications and to attract new people into amateur radio through “**convergence**”.

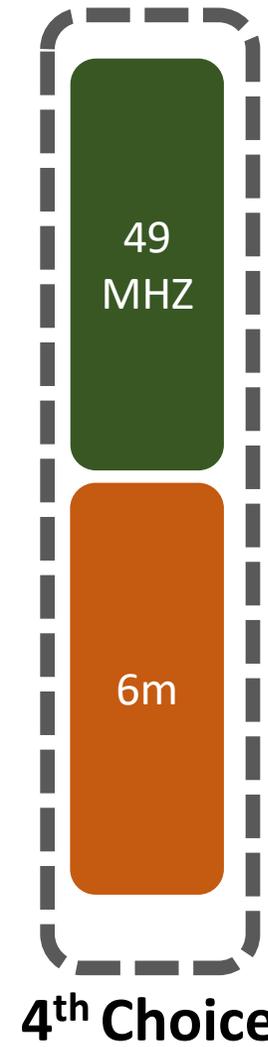
Inclusion & Spectrum



Inclusion & Spectrum

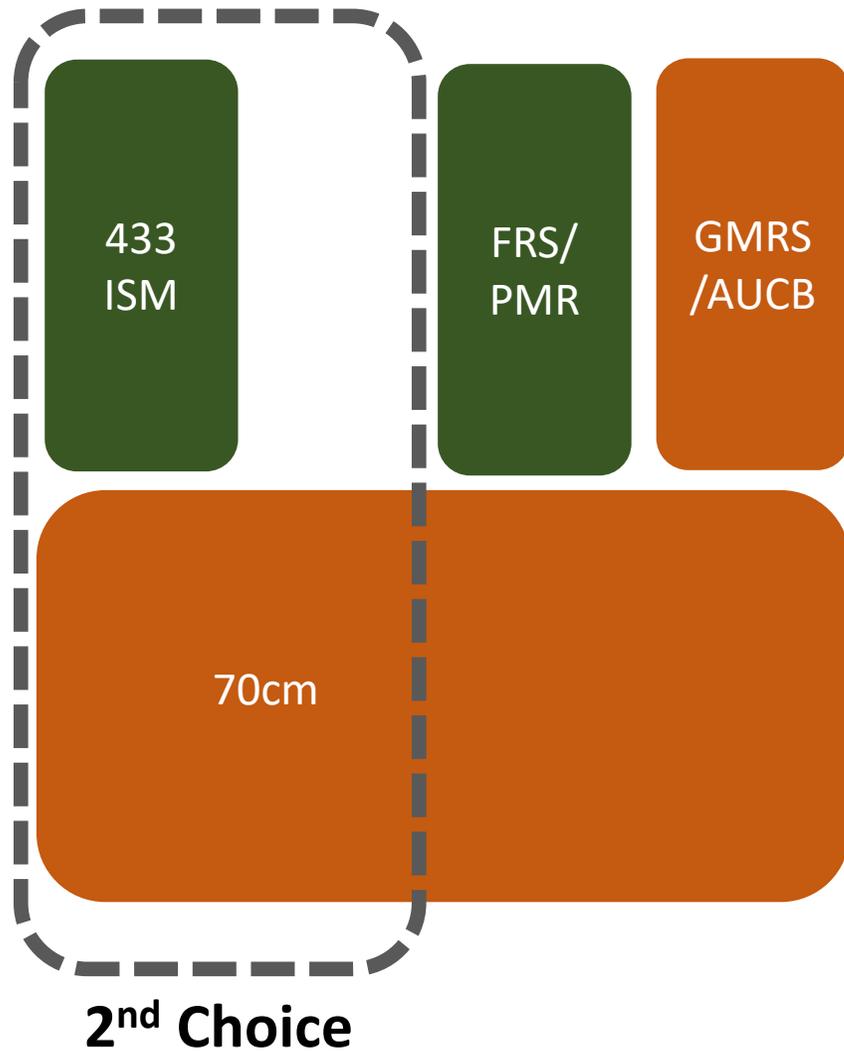


- Good: 2.4 GHz & 5.8 GHz are more known to general population as “Wi-Fi”
- Bad: 2.4 GHz & 5.8 GHz are more known to general population as “Wi-Fi”
- Would be hard to explain benefits of licensed versus unlicensed spectrum
- Even though amateur radio has spectrum above or below common Wi-Fi, getting equipment to support those frequencies at low cost is sometimes troublesome
- Do not want to create image of interference between amateur radio and Wi-Fi spectrum. Branding is important.
- Range is shortest and not as useful.



- Larger antenna required
- Fewer unlicensed users now as cordless phones have shifted to DSS or DECT (900 & 1700)
- No more analog TV interference due to digital shift
- Harder to find off the shelf small equipment
- R/C devices no longer using this spectrum as much. Now using 5.8 GHz and others.
- Did we say larger antenna already?

Inclusion & Spectrum



- Most potential and best range with moderate sized antennae
- The 420-450 MHz spectrum in USA and 430-440 in other countries is mostly protected as amateur only.
- More unlicensed users in the US and elsewhere in the 432-433 range.
- Do not want to motivate more unlicensed users in amateur spectrum or at least right away.
- Rise of digital hotspots mean we have more users in the lower part of spectrum now than in years past but there is plenty spectrum for everyone.
- Possible satellite interference from 435-438 MHz
- While equipment is easily found, felt best to use 433 band for later focus and use cases.

Inclusion & Spectrum



- More unlicensed users in the 902-928MHz more than ever (IoT, utility meters, etc)
- Amateur radio is considered a secondary user in the US.
- Potential for interference is less with amateur radio but more with other users.
- Amateurs must accept interference and that is ok. It makes us better.
- Amateurs can find ways to prevent interference with different modes and antennae.
- Equipment is plentiful and less cost compared to 433 MHz equipment in certain cases.
- Easier to experiment with. Antennae are $\frac{1}{2}$ size of 433 versions.
- Lessons learned in 900 MHz can apply to 433 MHz. Equipment is mostly interchangeable.
- Promote use of existing and potential amateurs in underused spectrum.

HASviolet: Where did the name come from?

(H) Hardware

(A) Antenna

(S) Software

Minimum or no soldering required

Repurposed for or from other projects

Inexpensive

Easy to purchase

Low cost

Easy to understand

Easy to build

Use for other projects

Repurpose knowledge

Inspire experimentation

Continuous development

Hardware agnostic

Clear instructions

Easy to install

Built in help

Inspiration for more learning

Convergence between radio and computer people

HASviolet: Where did the name come from?

Violet? =



Licensed &
unlicensed
spectrum



Chosen mode

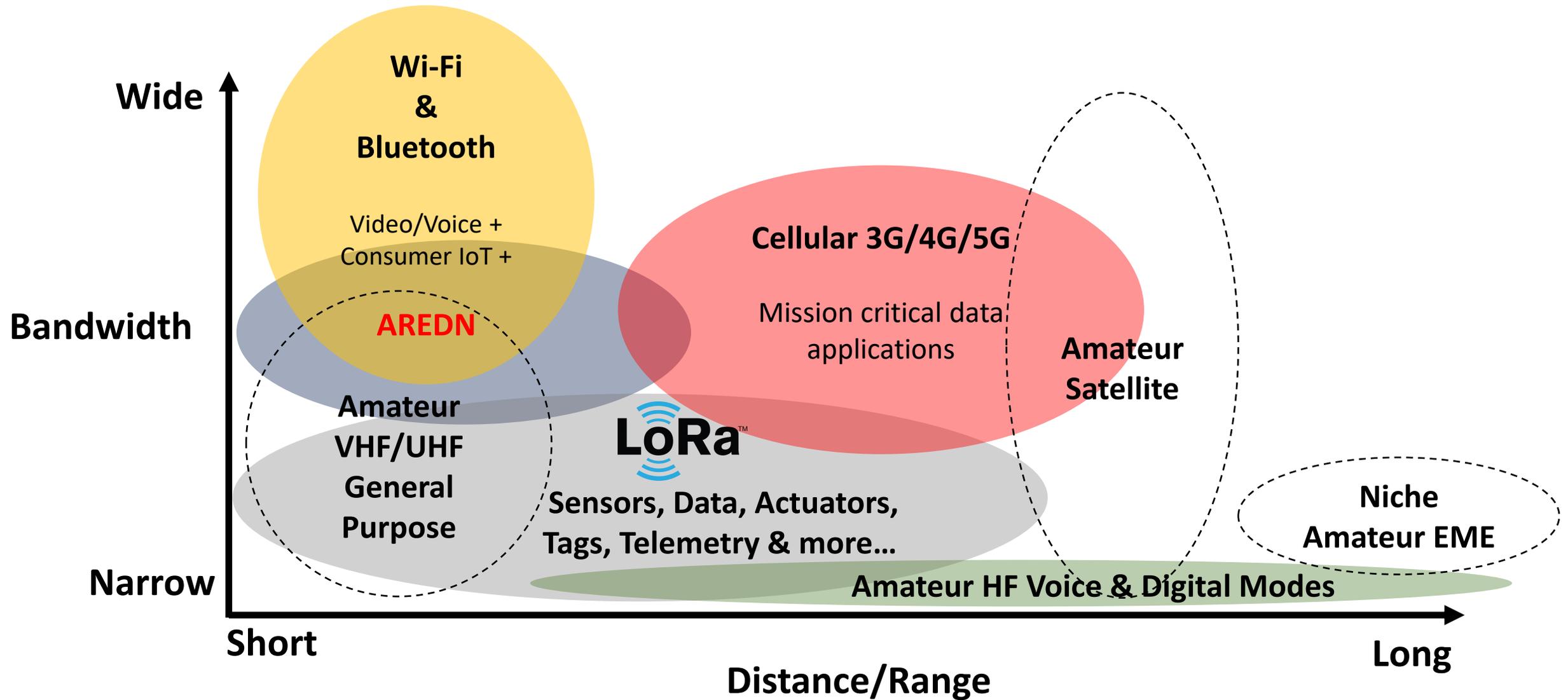


- Now that we found the spectrum and a default frequency, we now needed a mode that will provide innovation and unique applications relevant to the future of amateur radio.
- A commercial communication mode called LoRa is to be the underpinning of the HASviolet project due to its cost and flexibility along with technical benefits worth exploiting.

LoRaTM

The LoRa logo consists of the text 'LoRa' in a bold, black, sans-serif font, with a trademark symbol (TM) to the upper right of the 'a'. The letter 'o' is partially overlaid by a blue signal wave icon consisting of three curved lines above and three below the letter.

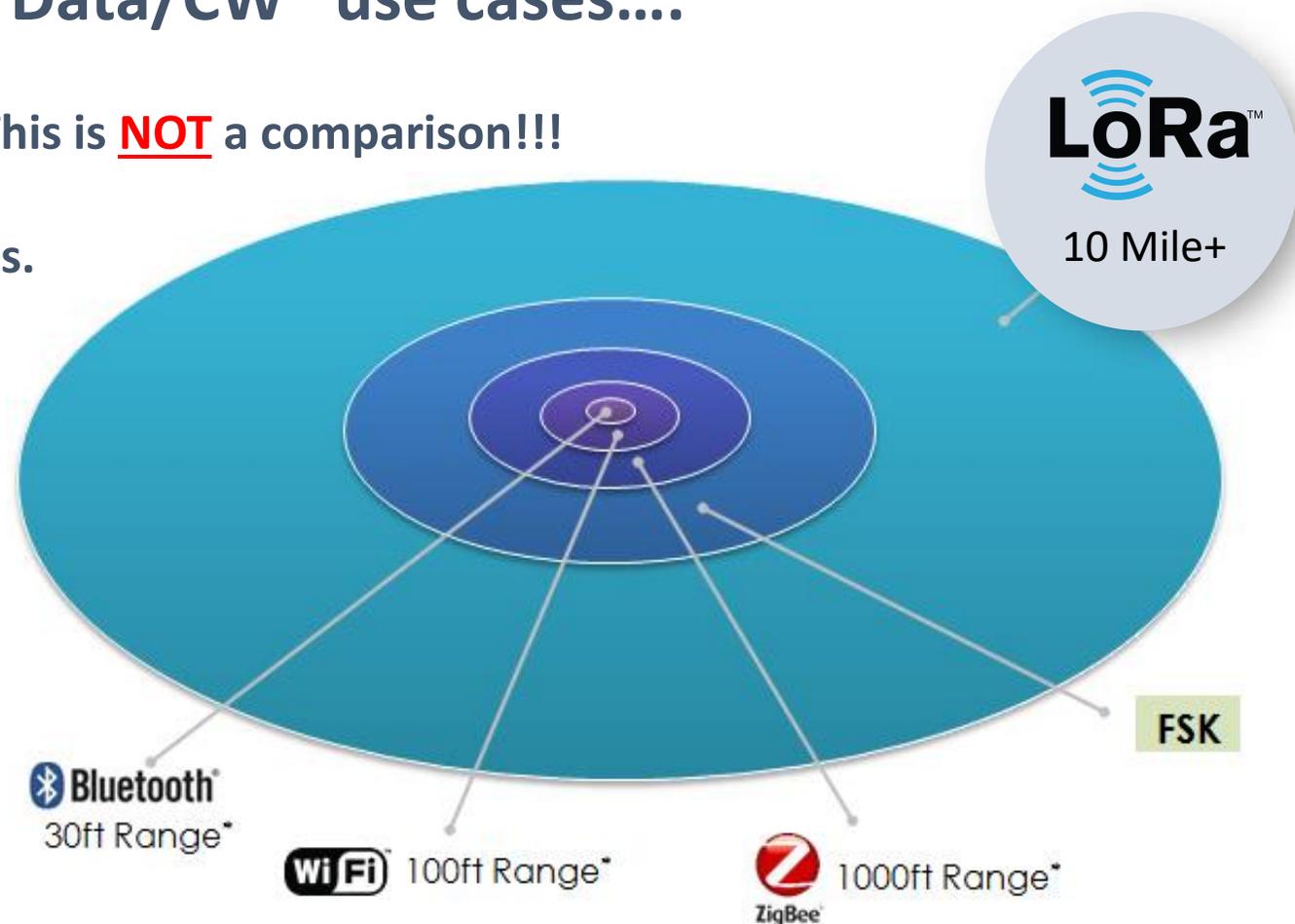
Solution Found: What is LoRa?



But what really is LoRa?

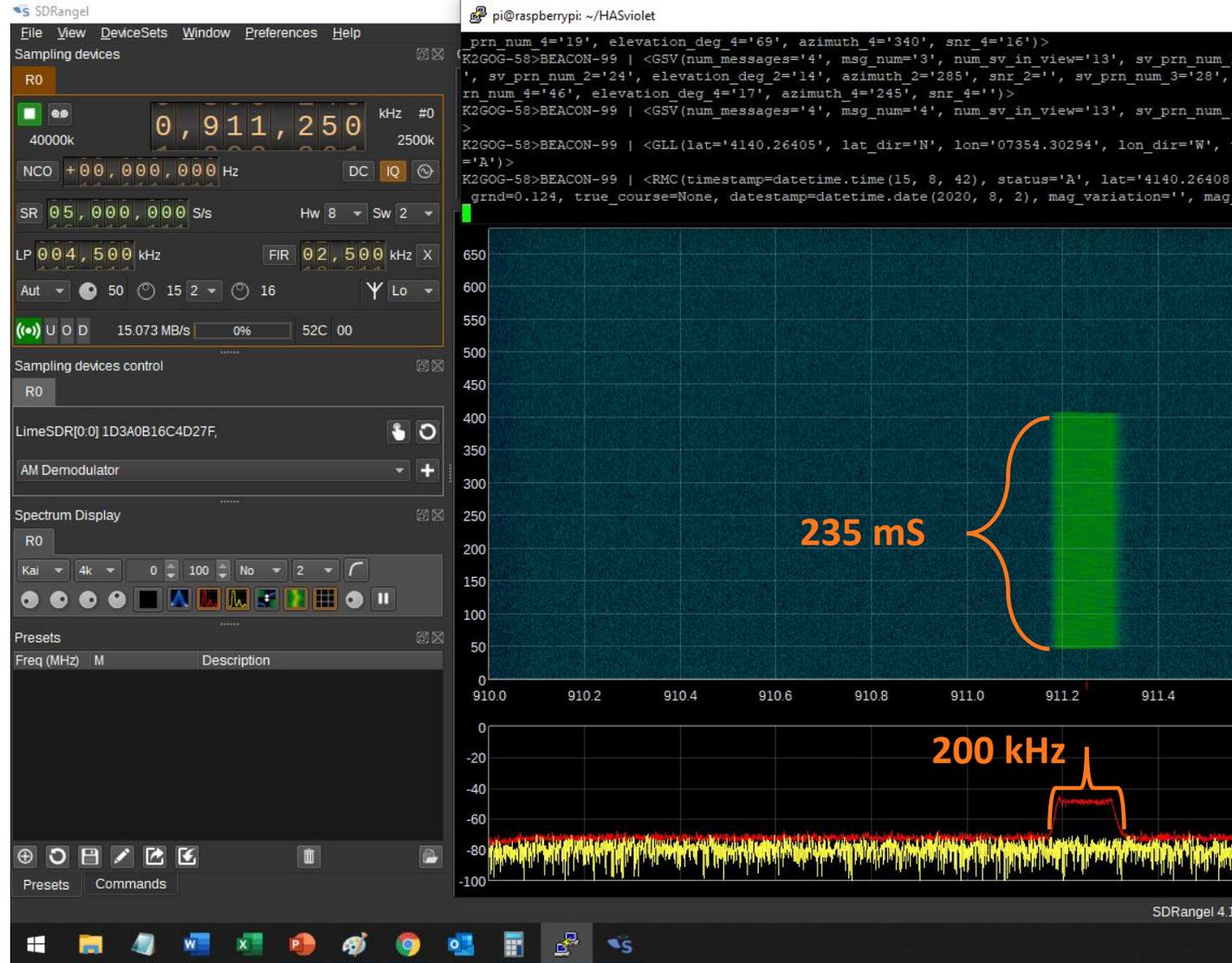
If we compared against amateur “HF Data/CW” use cases....

- It is not to replace CW and other modes on HF. This is **NOT** a comparison!!!
- This is not for DX only. Promotes other user cases.
- Super low -120dBm signal to noise capability
- 250 characters sent in a <1s “Burst”
- Variable bandwidth from <8kHz to ~250kHz
- Under 20 mA power consumption
- Spread spectrum options for reliability
- Suited for underused amateur spectrum? + its cheap....



But what really is LoRa?

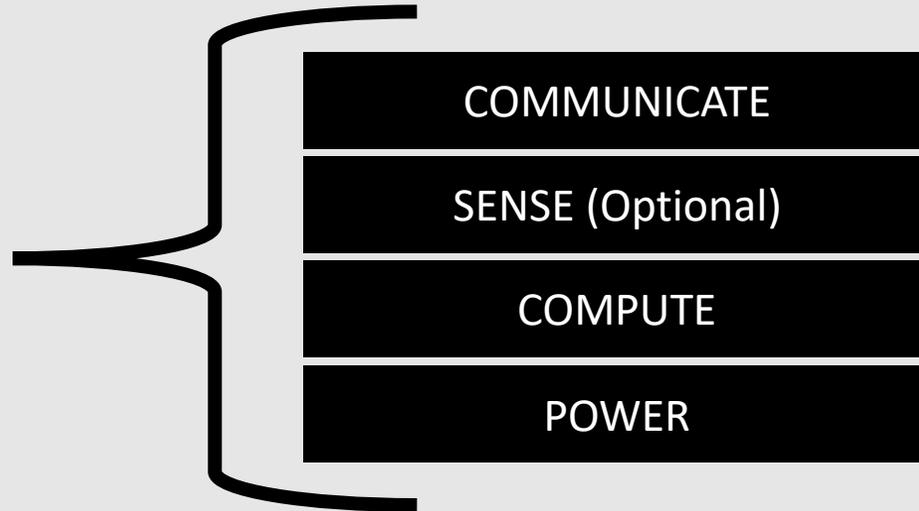
- Showing SDR Angel software to visualize a LoRa signal
- Example is a GPS data burst sent from HASviolet-gps.py (One of our applications)
- Over 40 different unique data points can be sent in about $\frac{1}{4}$ of a second
- Example shows wider bandwidth compared to traditional VHF & UHF AX.25 APRS at 12.5 kHz wide.
- More functionality can be realized for different data use cases with LoRa. Bandwidth, spread, etc can be changed. Not possible with APRS!!
- This is just one advanced use case. Its not just about GPS.....



Hardware

- HASviolet hardware comprises of different functional modules that are easy to assemble

Basic HASviolet Sandwich



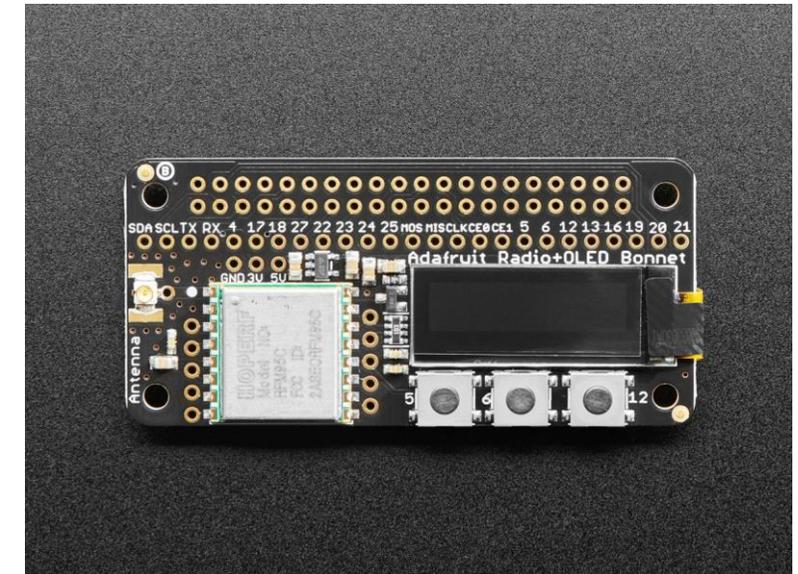
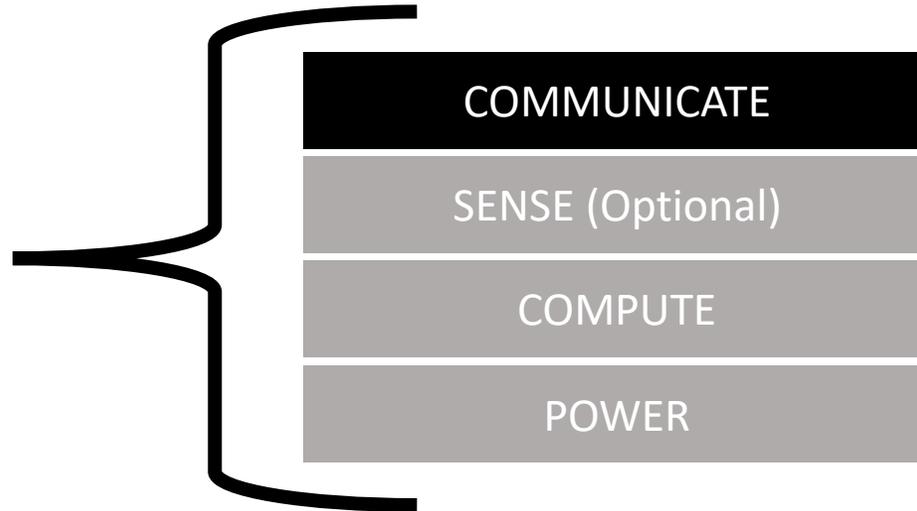
- Two versions shown: One built with a full-size Raspberry Pi for stationary use and a more portable one with a Raspberry Pi Zero. The bother otherwise are the same thing.



Hardware - Communicate

- HASviolet Communicate uses an Adafruit LoRa Radio Bonnet product for “off the shelf simplicity”
- Provides the 900 MHz communication. Can also support 433 MHz if interested....

Basic HASviolet
Sandwich

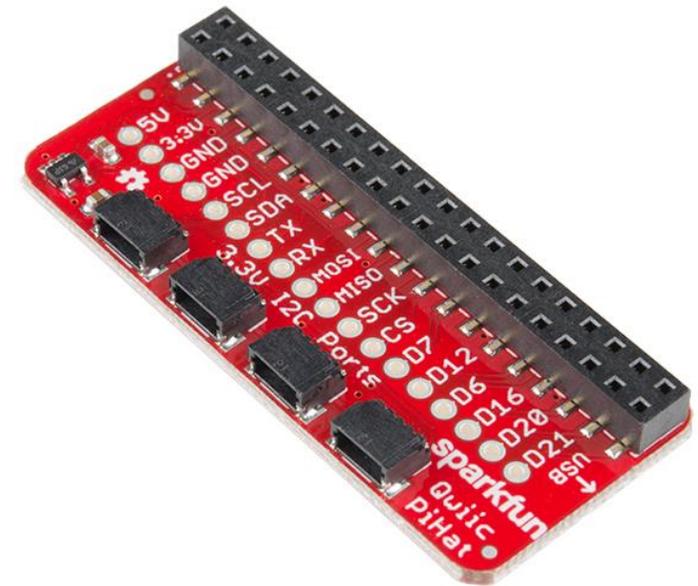
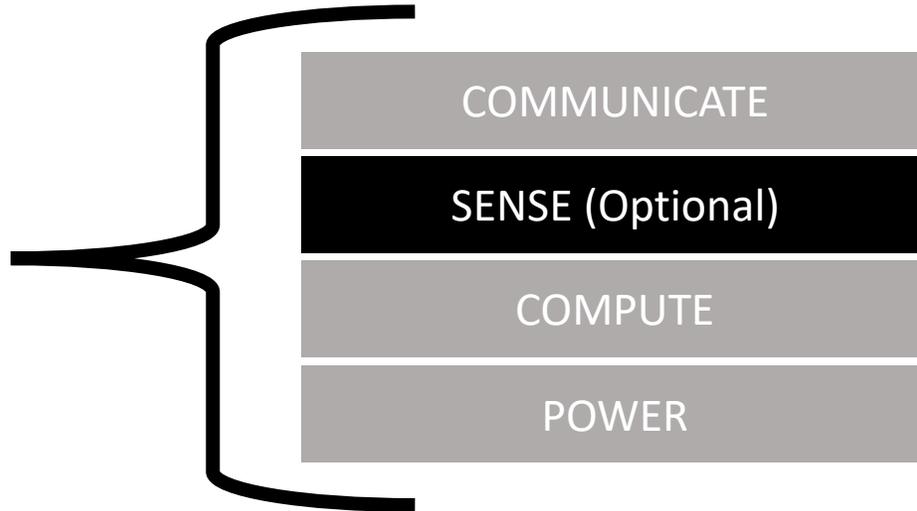


- A great feature of this approach is the 40-pin pass through style connector for use with a Raspberry Pi Zero
- Further technical details in the [Addendum – Hardware – Communicate](#) section

Hardware - Sense

- HASviolet Sense uses a Sparkfun QWIIC interface to allow easy integration of sensors with HASviolet
- The current application library supports different atmospheric, location and range finding I2C based sensors

Basic HASviolet
Sandwich

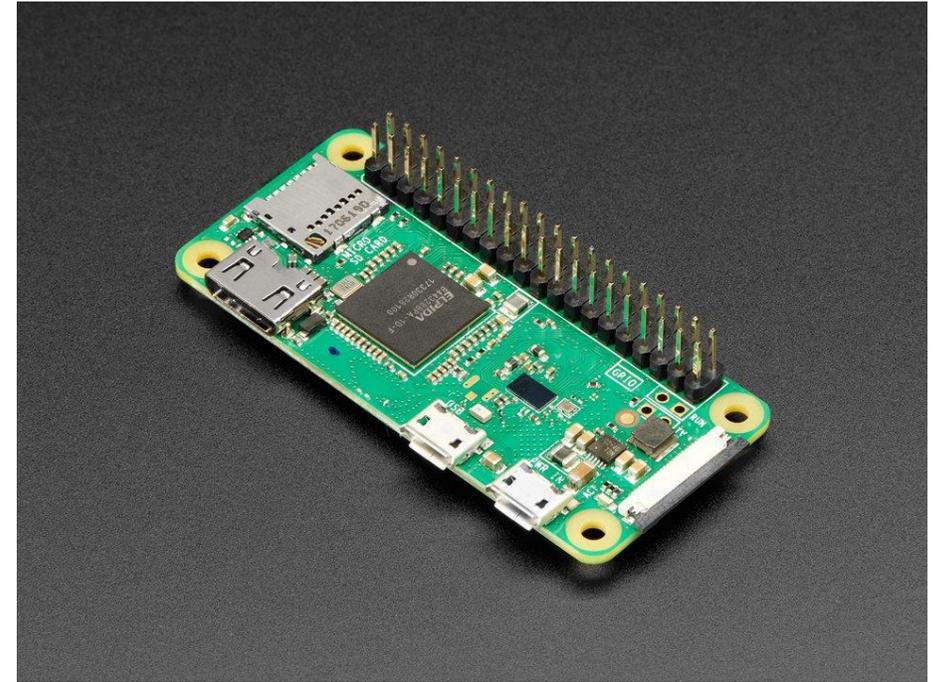
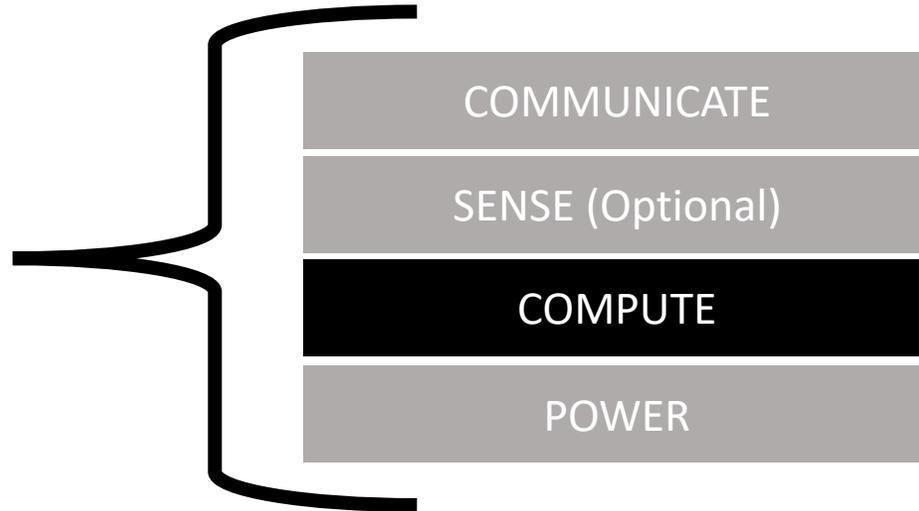


- A great feature of this approach is the 40-pin pass through style connector for use with a Raspberry Pi Zero

Hardware - Sense

- HASviolet Compute is based on the Raspberry Pi Zero Wireless. Only use v1.1 and v1.3. Avoid v1.2 versions!
- It is ok to purchase one with standard header as pictured or solder your own standard or extended length version.

Basic HASviolet
Sandwich

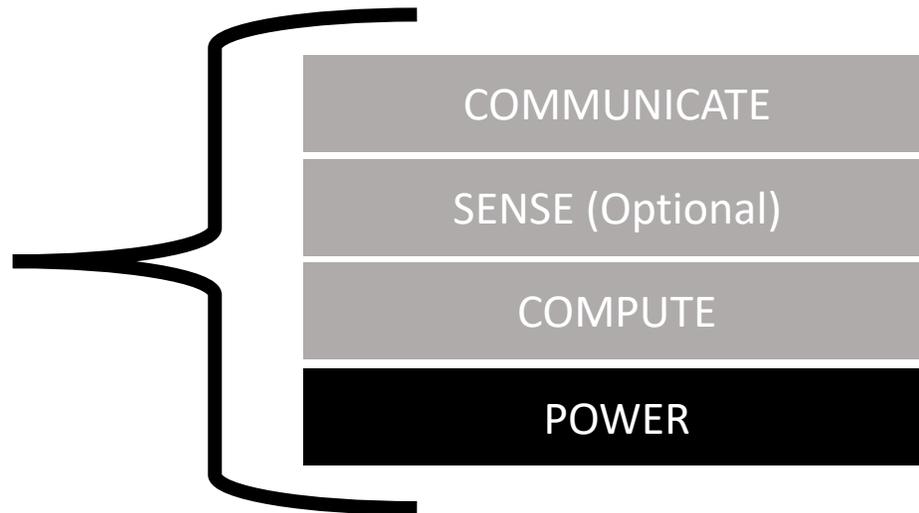


- Raspberry Pi Zero Wireless can be purchased from many different sources far too numerous to list.

Hardware - Power

- HASviolet Power can use different ways to power your device for different use cases
- HVVDN recommends the open source Pi Sugar product for streamlined portable use. No soldering is required.

Basic HASviolet
Sandwich



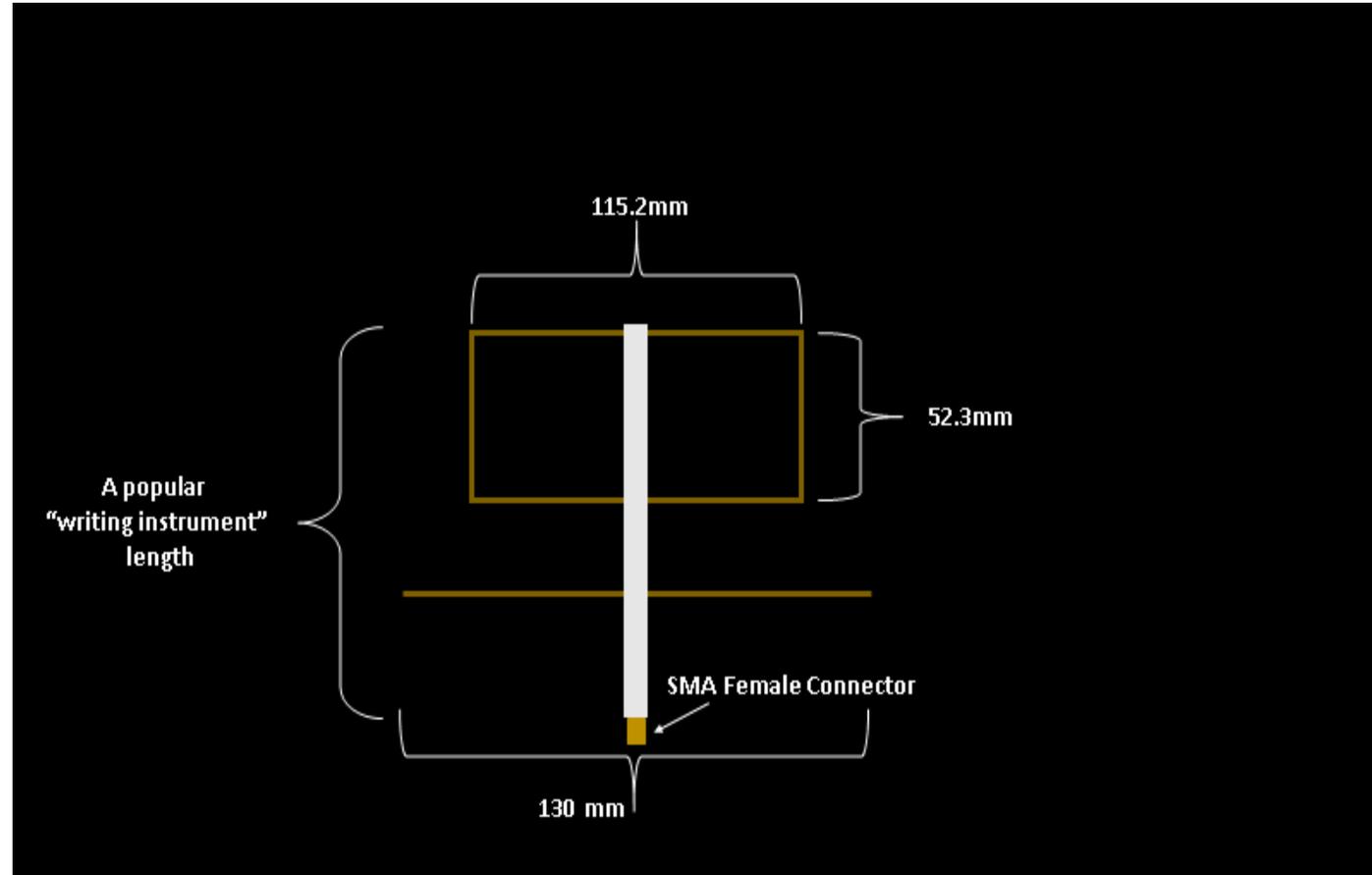
 PiSugar



- While a power bank can be used to power your device, be wary of stress on connectors to avoid damage of your Raspberry Pi Zero while using outside the home. More detail in [Addendum – Hardware – Power section](#)

Antenna

- There is a lack of non-amateur wireless antenna projects below 1 GHz.
- Our antenna design has been released as open source to permit experimentation and improvement.
- We wanted to show antenna theory beyond simple ground plane and Yagi designs which involve simple math
- The V1 antenna offers omni directional and directional capability for different use cases.
- More details at hvdn.org/violet



Software

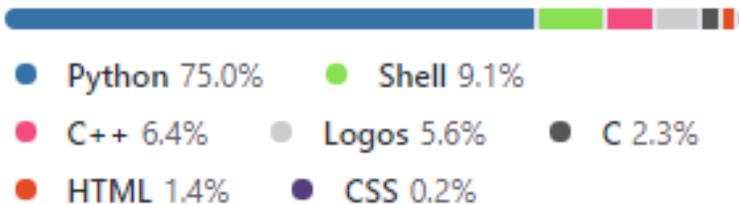
High Level Overview & Goals

- Familiar terminal-based access for setup and updates.
- Automated scripts to install all dependencies.
- Detailed project documentation on Git, our website and even built into the software.

Deeper Level Details & Goals

- Common programming to allow for expansion both for hardware, software and application driven needs.

Languages



```
pi@raspberrypi: ~  
login as: pi  
pi@192.168.1.241's password:  
Linux raspberrypi 5.4.51+ #1327 Thu Jul 23 10:53:06 BST 2020 armv6l  
  
The programs included with the Debian GNU/Linux system are free software;  
the exact distribution terms for each program are described in the  
individual files in /usr/share/doc/*/copyright.  
  
Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent  
permitted by applicable law.  
Last login: Sat Aug 1 22:48:18 2020 from 192.168.1.152  
pi@raspberrypi:~ $ ls  
HASviolet HASviolet_install.sh HVDN-repo  
pi@raspberrypi:~ $
```

HASviolet Applications - Basic

■ HASviolet-rx.py = basic receiver application

```
pi@raspberrypi:~/HASviolet $ ./HASviolet-rx.py -h
usage: HASviolet-rx.py [-h] [-r] [-s]

HASviolet RX

optional arguments:
  -h, --help            show this help message and exit
  -r, --raw_data        Receive raw data
  -s, --signal          Signal Strength
```

■ HASviolet-tx.py = basic transmitter application

```
pi@raspberrypi:~/HASviolet $ ./HASviolet-tx.py -h
usage: HASviolet-tx.py [-h] [-d DESTINATION] -m MESSAGE

HASviolet TX

optional arguments:
  -h, --help            show this help message and exit
  -d DESTINATION, --destination DESTINATION
                        Destination
  -m MESSAGE, --message MESSAGE
                        Message to be sent in quotes
pi@raspberrypi:~/HASviolet $
```

```
pi@raspberrypi: ~/HASviolet
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
Last login: Sat Aug  1 22:48:18 2020 from 192.168.1.152
pi@raspberrypi:~ $ ls
HASviolet  HASviolet_install.sh  HVDN-repo
pi@raspberrypi:~ $ cd HASviolet
pi@raspberrypi:~/HASviolet $ ls
font5x8.bin                HASviolet-install-service.sh
HASviolet-atmos.py         HASviolet-install.sh
HASviolet-beacon.py       HASvioletRF.py
HASviolet-chat.py         HASviolet-rx.py
HASviolet-config.py       HASviolet-sensors.py
HASviolet-distance.py     HASviolet.service
HASviolet-duckhunt-config.py HASviolet-service.sh
HASviolet-duckhunt.ini    HASviolet-tx.py
HASviolet-gps.py          hvdn-logo.xbm
HASviolet-handheld.py     __pycache__
HASvioletHID.py           README.md
HASviolet.ini             rf95.py
HASviolet-install-refresh.sh
pi@raspberrypi:~/HASviolet $
```

HASviolet Applications - Basic

HASviolet-beacon.py = basic semi-automated transmitter

```
pi@raspberrypi:~/HASviolet $ ./HASviolet-beacon.py -h
usage: HASviolet-beacon.py [-h] -c COUNT -t TIME [-m MESSAGE]

HASviolet Beacon

optional arguments:
  -h, --help            show this help message and exit
  -c COUNT, --count COUNT
                        number of times to repeat the message
  -t TIME, --time TIME  number of seconds between repeating message
  -m MESSAGE, --message MESSAGE
                        Message to be broadcast in quotes. Default is beacon
                        setting from INI file
```

HASviolet-chat.py = basic two-way text communicator

```
pi@raspberrypi:~/HASviolet $ ./HASviolet-chat.py

HASviolet Chat
(Entering RX mode ... use Ctrl-Z to send, Ctrl-C to exit)
-----
█
```

```
pi@raspberrypi: ~/HASviolet

the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
Last login: Sat Aug  1 22:48:18 2020 from 192.168.1.152
pi@raspberrypi:~ $ ls
HASviolet  HASviolet_install.sh  HVDN-repo
pi@raspberrypi:~ $ cd HASviolet
pi@raspberrypi:~/HASviolet $ ls
font5x8.bin                HASviolet-install-service.sh
HASviolet-atmos.py         HASviolet-install.sh
HASviolet-beacon.py        HASvioletRF.py
HASviolet-chat.py          HASviolet-rx.py
HASviolet-config.py        HASviolet-sensors.py
HASviolet-distance.py     HASviolet.service
HASviolet-duckhunt-config.py HASviolet-service.sh
HASviolet-duckhunt.ini    HASviolet-tx.py
HASviolet-gps.py           hvdn-logo.xbm
HASviolet-handheld.py      __pycache__
HASvioletHID.py            README.md
HASviolet.ini              rf95.py
HASviolet-install-refresh.sh
pi@raspberrypi:~/HASviolet $
```

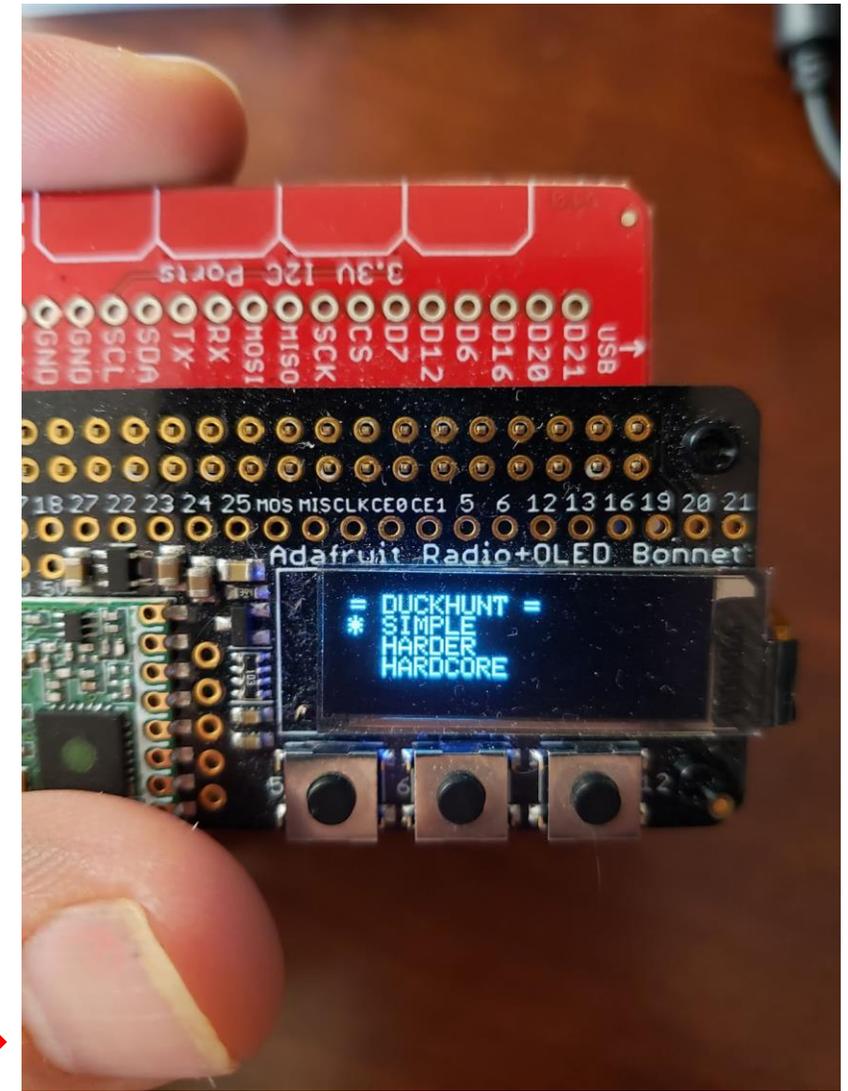
HASviolet Applications – Next Generation

- **HASviolet-gps.py = next generation GPS NMEA strings....**

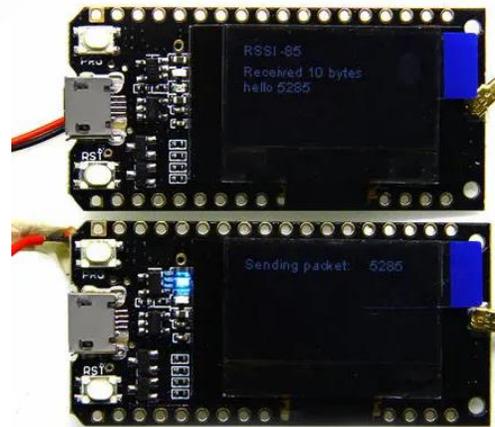
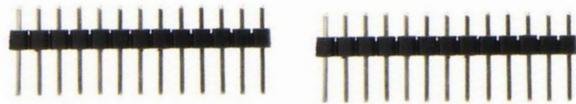
```
pi@raspberrypi:~/HASviolet $ ./HASviolet-gps.py
K2GOG-58>BEACON-99 | <TXT(num_msg='01', msg_num='01', msg_type='02', text='u-blox ag - www.u-blox.com')>
K2GOG-58>BEACON-99 | <TXT(num_msg='01', msg_num='01', msg_type='02', text='HW UBX-G70xx 00070000 ')>
K2GOG-58>BEACON-99 | <TXT(num_msg='01', msg_num='01', msg_type='02', text='ROM CORE 1.00 (59842) Jun 27 2012 17:43:52')>
K2GOG-58>BEACON-99 | <TXT(num_msg='01', msg_num='01', msg_type='02', text='PROTV ER 14.00')>
K2GOG-58>BEACON-99 | <TXT(num_msg='01', msg_num='01', msg_type='02', text='ANTSU PERV=AC SD PDoS SR')>
K2GOG-58>BEACON-99 | <TXT(num_msg='01', msg_num='01', msg_type='02', text='ANTSTATUS=OK')>
K2GOG-58>BEACON-99 | <TXT(num_msg='01', msg_num='01', msg_type='02', text='LLC FFFFFFFF-FFFFFFFD-FFFFFFFF-FFFFFFFF-FFFFFFFF9')>
K2GOG-58>BEACON-99 | <RMC(timestamp=datetime.time(0, 10, 5), status='A', lat='4140.27286', lat_dir='N', lon='07354.30409', lon_dir='W', spd_over_grnd=0.165, true_course=None, datestamp=datetime.date(2020, 8, 2), mag_variation='', mag_var_dir='') data=['A']>
```

- **HASviolet-duckhunt.py = next generation smart location and sensor-based RDF/Fox Hunt called “Duck Hunt”**

- **This combines location intelligence, sensor data and automated (and controlled) transmission. The reason why the other applications exist!**



Related LoRa Projects



- Will be better for “node” applications and the RPI based version will be considered a “gateway” or “enhanced” version since its CPU draws more power.
- ESP32 based development boards can be used as a “lite” but fully compatible with the HASviolet project and better suited for Duckhunt.
- Development work is already on our Git repository
- Different applications compared to Disaster Radio project



What is next for HASviolet?

- **More focus on ESP32 based solutions that integrate LoRa, GPS and power on one board.**
- **Promote awareness of “Duck Hunt” to engage different audiences for outside in person events to highlight radio direction finding.**
- **Continued development on “next generation” APRS through XARPS which is a topic in later material as the future of APRS.**

Where can I find more about HASviolet?

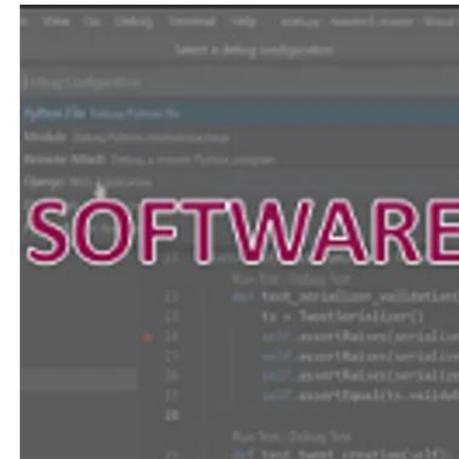
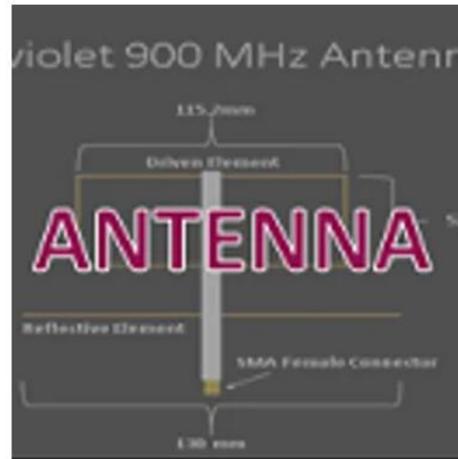
hvdn.org/violet

Want E-Mail Updates?

Email

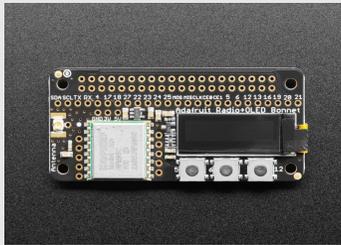
SIGN UP

QUICK ACCESS TO ARTICLES ABOUT...

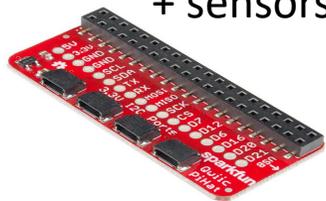


Getting Started for \$100 (USD)

Hardware

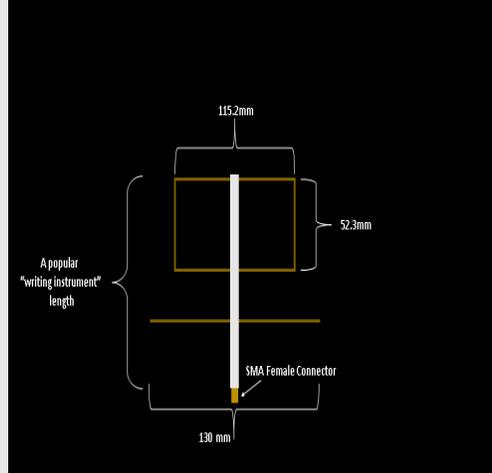


+ sensors



+ POWER

Antenna



Or other options...



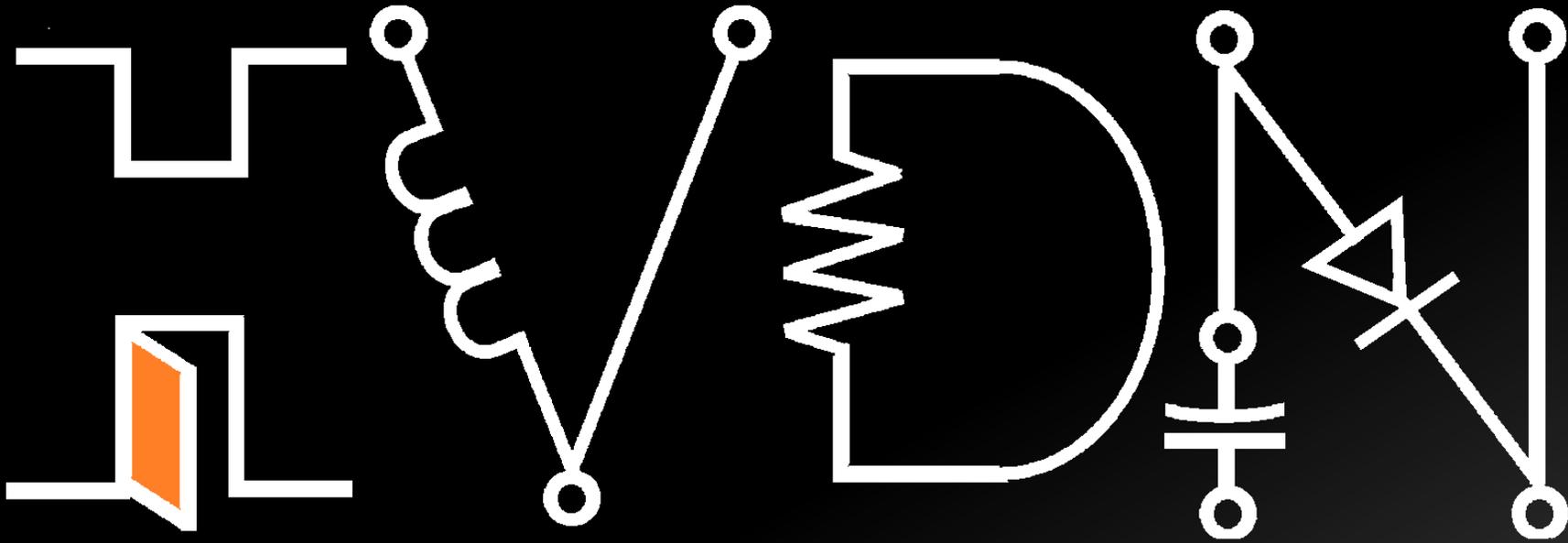
Software



hvdn.org/violet



<https://hvdn.org/donate>



Hudson Valley Digital Network | www.hvdsn.org /presentations

LoRa & HASviolet

Addendum - Hardware - Communicate

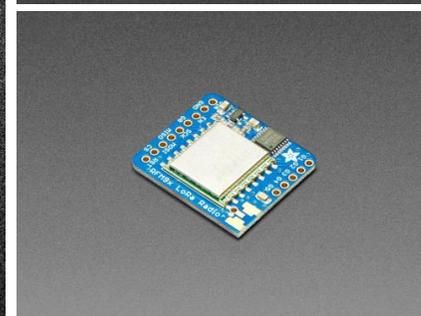
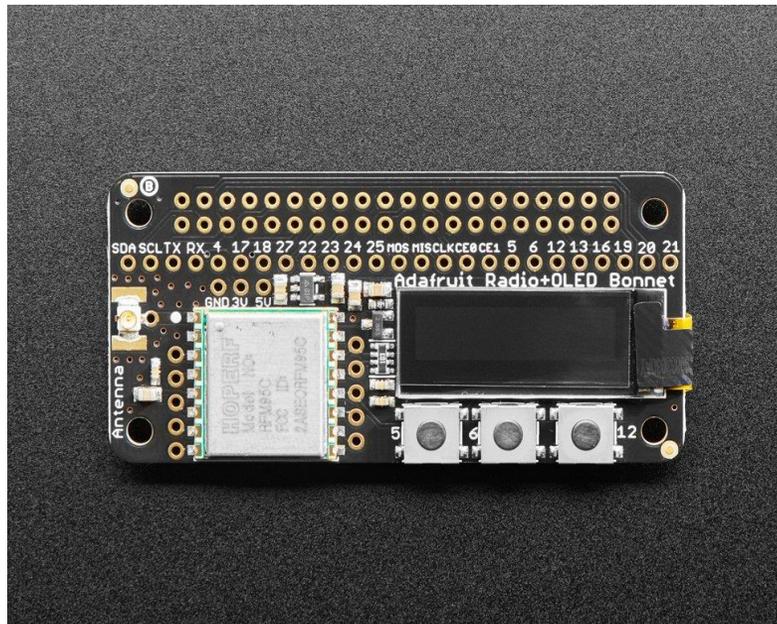
- You will really want to purchase in multiples of two!
- [RFM95W](#) (ID: 4074) has longer range since it INCLUDES LoRa. The RFM69HCW does not. Do not try to be cheap!
- The benefit of buying the Adafruit “bonnet” is off the shelf hardware with user interface.
- An alternate option is the [RFM95W](#) (ID: 3072) module but will NOT easily connect with a Raspberry Pi Zero.

- Which ONE to purchase?

- LoRa RFM95W @ 915MHz
- RFM69HCW @ 915MHz (\$19.95)
- RFM69HCW @ 433MHz (\$19.95)
- LoRa RFM96W @ 433MHz

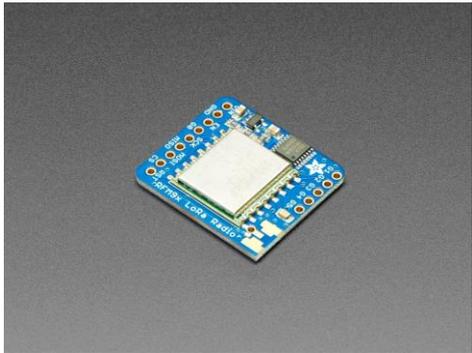
- Where to purchase?

<https://www.adafruit.com/product/4074>



Addendum - Hardware - Communicate

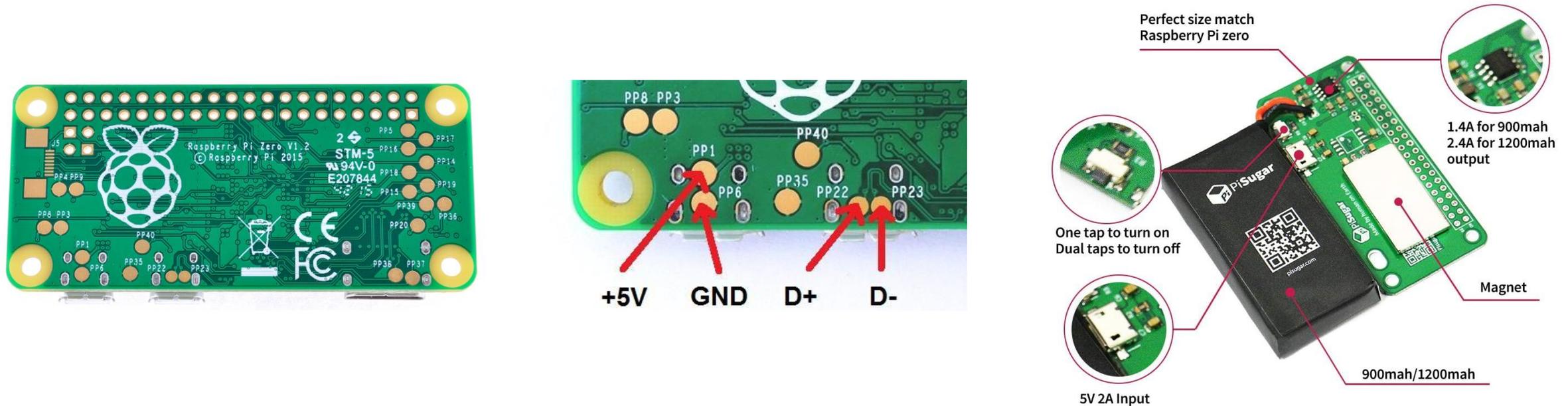
Additional Technical Details on the SX1276 based module used by Adafruit and HVDN HASviolet



- Packet radio with ready-to-go CircuitPython libraries
- Uses the license-free ISM band: "European ISM" @ 868MHz or "American ISM" @ 915MHz
- Use a simple wire antenna or spot for uFL or SMA radio connector
- SX1276 LoRa[®] based module with SPI interface
- +5 to +20 dBm up to 100 mW Power Output Capability (power output selectable in software)
- ~100mA peak during +20dBm transmit, ~30mA during active radio listening.
- Range of approx. 2Km, depending on obstructions, frequency, antenna and power output

Addendum - Hardware - Power

Applying power and turning off a Raspberry Pi has been confusing for some people since its introduction



- The bottom of the Raspberry Pi Zero has test pads where power and communications can be added
- There are different power solutions that require no solder for use with the Raspberry Pi Zero
- The [Pi Sugar](#) products are the most professional open source and reliable solution on the market today