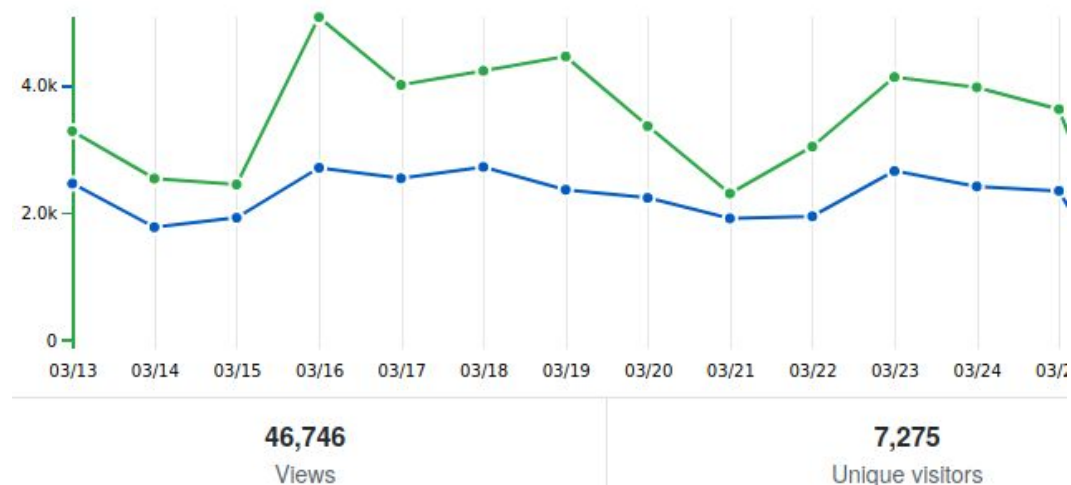# ArduPilot Systems Update 2020

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2020 Overview

Very active year!

- 5k patches merged
- over 500k lines of code changed
- 150 contributors

46,746 Views   7,275 Unique visitors

ChibiOS HAL

Key changes

- Final phase out of NuttX complete
- H7 support in stable releases
- Lots of new boards
  - CUAV-Nora, CUAV_GPS, CUAVv5Nano, CubeBlack+, CubeSolo, Durandal, KakuteF7Mini, MatekF765-Wing, R9Pilot, SuccexF4, f103-periph, f303-periph, luminousbee4, mRoRonctrolZeroF7, omnibusf4

New Sensor Config System

- Aiming for only hwdef.dat for new boards

Old system with scattered #ifdefs

```
#elif HAL_COMPASS_DEFAULT == HAL_COMPASS_HMC5843_MPU6000
    ADD_BACKEND(DRIVER_HMC5883, AP_Compass_HMC5843::probe_mpu6000());
#elif  HAL_COMPASS_DEFAULT == HAL_COMPASS_AK8963_I2C
    ADD_BACKEND(DRIVER_AK8963, AP_Compass_AK8963::probe(GET_I2C_DEVICE(HAL_COMPASS_AK8963_I2C_BUS, HAL_COMPASS_AK8963_I2C_ADDR)));
#elif HAL_COMPASS_DEFAULT == HAL_COMPASS_AK8963_MPU9250_I2C
    ADD_BACKEND(DRIVER_AK8963, AP_Compass_AK8963::probe_mpu9250(GET_I2C_DEVICE(HAL_COMPASS_AK8963_I2C_BUS, HAL_COMPASS_AK8963_I2C_ADDR)));
#elif HAL_COMPASS_DEFAULT == HAL_COMPASS_AERO
    ADD_BACKEND(DRIVER_BMM150, AP_Compass_BMM150::probe(GET_I2C_DEVICE(HAL_COMPASS_BMM150_I2C_BUS, HAL_COMPASS_BMM150_I2C_ADDR)));
    ADD_BACKEND(DRIVER_HMC5883, AP_Compass_HMC5843::probe(GET_I2C_DEVICE(HAL_COMPASS_HMC5843_I2C_BUS, HAL_COMPASS_HMC5843_I2C_ADDR), true));
    ADD_BACKEND(DRIVER_IST8310, AP_Compass_IST8310::probe(GET_I2C_DEVICE(HAL_COMPASS_IST8310_I2C_BUS, HAL_COMPASS_IST8310_I2C_ADDR),
                                                          true, ROTATION_PITCH_180_YAW_90));
#elif HAL_COMPASS_DEFAULT == HAL_COMPASS_LIS3MDL
    ADD_BACKEND(DRIVER_LIS3MDL, AP_Compass_LIS3MDL::probe(hal.spi->get_device(HAL_COMPASS_LIS3MDL_NAME), false, ROTATION_ROLL_180_YAW_90));
#elif HAL_COMPASS_DEFAULT == HAL_COMPASS_MAG3110
```
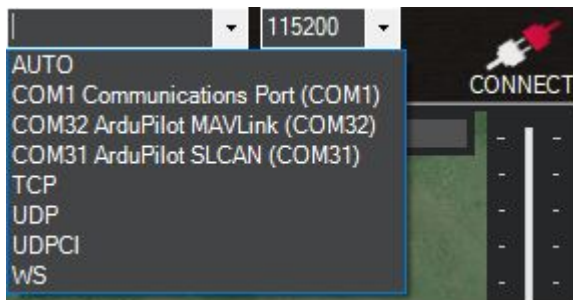
New System in hwdef.dat

```
IMU Invensense SPI:icm20602_ext ROTATION_ROLL_180_YAW_270
BARO MS56XX SPI:ms5611
COMPASS LSM303D SPI:lsm9ds0_ext_am ROTATION_YAW_270
```

New USB IDs

[New USB IDs](#) for better user experience

- New ID for composite devices (SLCAN)
- New ID for non-composite devices
- New vendor IDs

BRD_ALT_CONFIG

New runtime hardware config system

- reconfigure hardware at runtime
- switch pins between peripheral types
- set BRD_ALT_CONFIG then reboot

Switch PB3 from a UART to a timer:

PB3 UART7_RX UART7
PB3 TIM2_CH2 TIM2 RCININT PULLDOWN LOW ALT(1)

AP_Vehicle Refactor

Big step forward in common code

- continues effort toward common behaviour
- adds common scheduling and param tables
- easier to add new features to all vehicles

```
/*
  common scheduler table for fast CPUs - all common vehicle tasks
  should be listed here, along with how often they should be called (in hz)
  and the maximum time they are expected to take (in microseconds)
 */
const AP_Scheduler::Task AP_Vehicle::scheduler_tasks[] = {
#if HAL_RUNCAM_ENABLED
    SCHED_TASK_CLASS(AP_RunCam,     &vehicle.runcam,          update,                    50, 50),
#endif
#if HAL_GYROFFT_ENABLED
    SCHED_TASK_CLASS(AP_GyroFFT,    &vehicle.gyro_fft,        sample_gyros,      LOOP_RATE, 50),
    SCHED_TASK_CLASS(AP_GyroFFT,    &vehicle.gyro_fft,        update_parameters,         1, 50),
#endif
};
```

Credit: Peter and Andy

CAN Updates

Major CAN changes from 2020

- new CAN protocols: Piccolo, ToshibaCAN
- HereFlow released
- dual-USB for easy SLCAN
- RTK on UAVCAN supported
- new UAVCAN DNA system
- MissionPlanner CAN UI

2019 was the year of CAN development

2020 should be the year of CAN users

Credit: Sid and Michael

AP_Periph

AP_Periph 1.0 stable

- Supports GPS, Mag, Baro, Airspeed, ADSB, LEDs, Rangefinder, buzzer, switch, HW ESC
- New f303 board, universal firmware

AP_Periph customization

- Hobbywing ESC adapter
- Hardpoint trigger

AP_Filesystem

New VFS system [#13911](#)

- API separation allowing for virtual filesystems
- Present system data as filesystems
  - @ROMFS
  - @PARAM
  - @SYS
- Future plans
  - @MISSION for mission download/upload

AP_Filesystem (2)

ROMFS Filesystem

- All of ROMFS in @ROMFS/ directory
    - scripts/ folder for Lua scripts
    - allows scripts built into firmware
    - removes dependency on microSD
    - hwdef.dat for board in @ROMFS/hwdef.dat
    - all files compressed in flash

AP_Filesystem (3)

Param Filesystem

- Packed parameters in @PARAM/param.pck
  - very fast parameter download
    - approx 30x faster on USB
    - approx 4x faster on 57k SiK radio
  - packed format uses approx 9 bytes per param
  - Tools/scripts/param_unpack.py to unpack
    - integration into GCS needed

Sys Filesystem

- Arbitrary system information
  - simple API to present information
  - @SYS/threads.txt for thread information

```
ArduCopter      PRI=182 STACK_LEFT=6616
idle            PRI=  1 STACK_LEFT=272
apm_uart        PRI= 60 STACK_LEFT=2096
apm_monitor     PRI=183 STACK_LEFT=624
apm_timer       PRI=181 STACK_LEFT=2152
apm_rcin        PRI=177 STACK_LEFT=632
apm_io          PRI= 58 STACK_LEFT=1584
apm_storage     PRI= 59 STACK_LEFT=2208
IOMCU           PRI=183 STACK_LEFT=880
SPI:4           PRI=181 STACK_LEFT=776
SPI:1           PRI=181 STACK_LEFT=768
FTP             PRI= 58 STACK_LEFT=2376
```

Watchdog System

Differentiate software and hardware faults

- previously had no way to track cause of faults
- sometimes misdiagnosed as power failure

Watchdog logging

- WDOG message for diagnostics
- restore key state for fixed wing

WDOG {TimeUS : 1481655, Tsk : 4, IErr : 2048, IEC : 1, MM : 0, MC : 0, SL : 0,

FL : 106, FT : 3, FA : 3758157112, FP : 180, ICSR : 4413443, E1 : 28, E2 : -1}

Compass Improvements

Big compass improvements

- new compass ID system
- use of WMM for more robust mag fusion
- compass scale factor support

Compass Priority

Set the Compass Priority by reordering the compasses in the table below (Highest at the top)

DevID	BusType	Bus	Address	DevType	Up	Down
590114	SPI	4	1	AK09916	⬆	⬇
95235	UAVCAN	0	116	SENSOR_ID#1	⬆	⬇
0	UNKNOWN	0	0	0	⬆	⬇
0	UNKNOWN	0	0	0	⬆	⬇
0	UNKNOWN	0	0	0	⬆	⬇
0	UNKNOWN	0	0	0	⬆	⬇
0	UNKNOWN	0	0	0	⬆	⬇
0	UNKNOWN	0	0	0	⬆	⬇

Credit: Sid and Michael

Filtering Options

Big improvements in filtering

- harmonic notch filter for better tuning
- realtime FFT support makes filtering easier
  - detect oscillation peak frequency
  - adjust filters in real time
  - greatly helps with copter tuning

Credit: Andy, Bill and Leonard

Key Driver Changes

Many new and enhanced drivers

- moving baseline GPS for yaw and F9P support
- WS2812 LEDs
- EFI support
- FPort for one-wire RC and telemetry
- new invensense API supported
- CAN rangefinders
- runcam support

Planned Work

Some key changes planned for 2020

- FDCAN support (Sid)
- bi-directional DShot for fast RPM
- Fix performance regressions
- DMA contention improvements
- fast USB support (CUAV Nora)