SkyDive
Unmanned Aerial System

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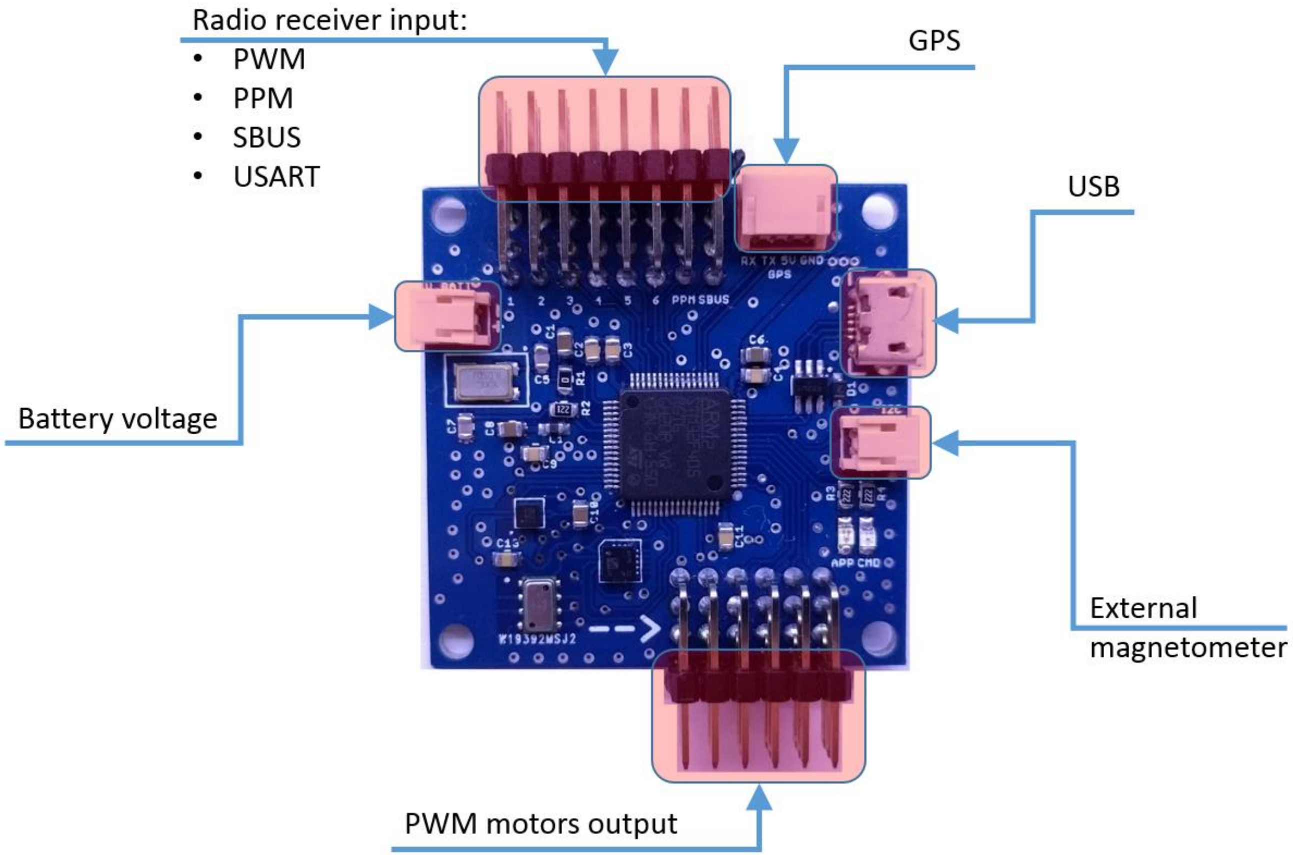
Parts of the system

- Controller board
- Communication protocol
- User application
    - Desktop
    - Mobile
- Drone over LTE – forwarding server
- Test environment
    - Legacy security
    - Flight simulator

Controller board - hardware

- Internal IMU
  - Accelerometer
  - Gyroscope
  - Magnetometer
  - Barometer
- 400Hz control frequency
- Data logger support
- Only 43x43 millimetres size



Radio receiver input:

- PWM
- PPM
- SBUS
- USART

GPS

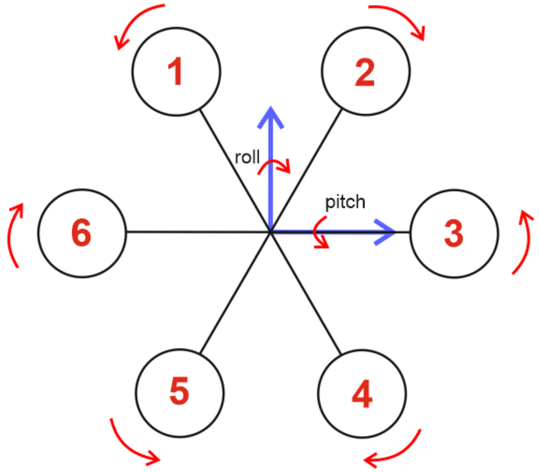
USB

Battery voltage

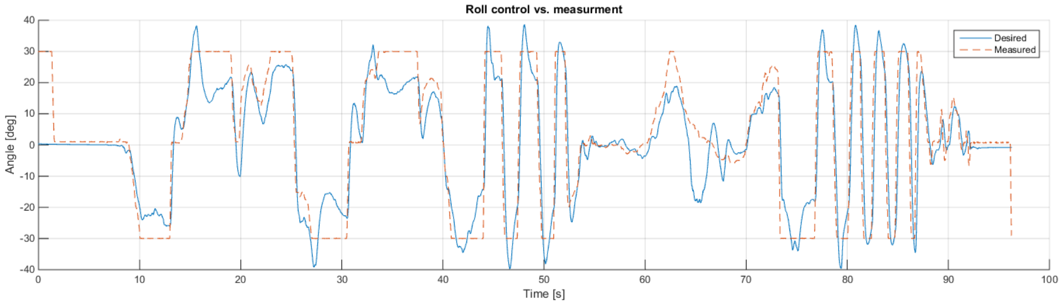
External magnetometer

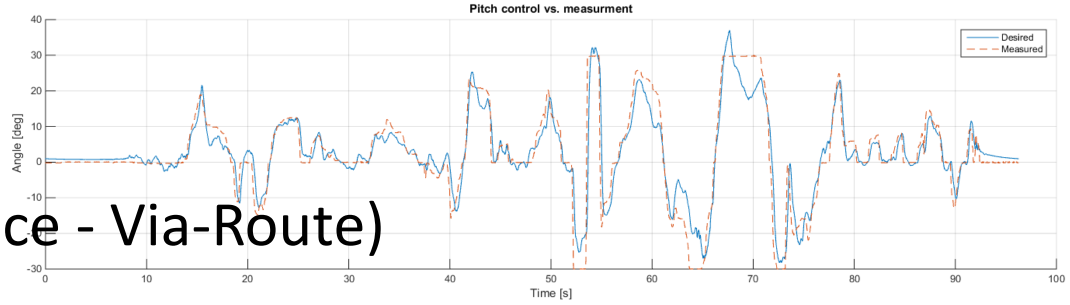
PWM motors output

Controller board - algorithms



- Multiple multirotor configurations
- Sensors calibration
- Full state estimation
- Rotation control
  - Rotation rate
  - Rotation angles
- Position (autopilot)
  - Altitude
  - Position change rate
  - Position (specific position or sequence - Via-Route)

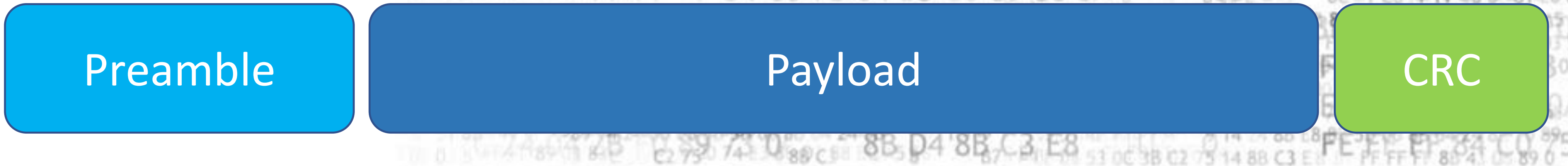

Roll control vs. measurment


Pitch control vs. measurment

Flight movie – 1:48

- Move with black hexacopter with hold position and rotation

Communication protocol



- **Preamble contains 3 the same bytes and ‘0’, example: {$, $, $, 0}**
- **Payload length varies in case of preamble type**
- **Payload contains serialized protocol data structures**
- **16 bits CRC sum is computed only from payload**

Control – {$, $, $, 0}

- Size: 48 bytes
- Control
- Telemetry
- Payload data layout depends on transmission direction
- UDP transport layer

Signal – {%, %, %, 0}

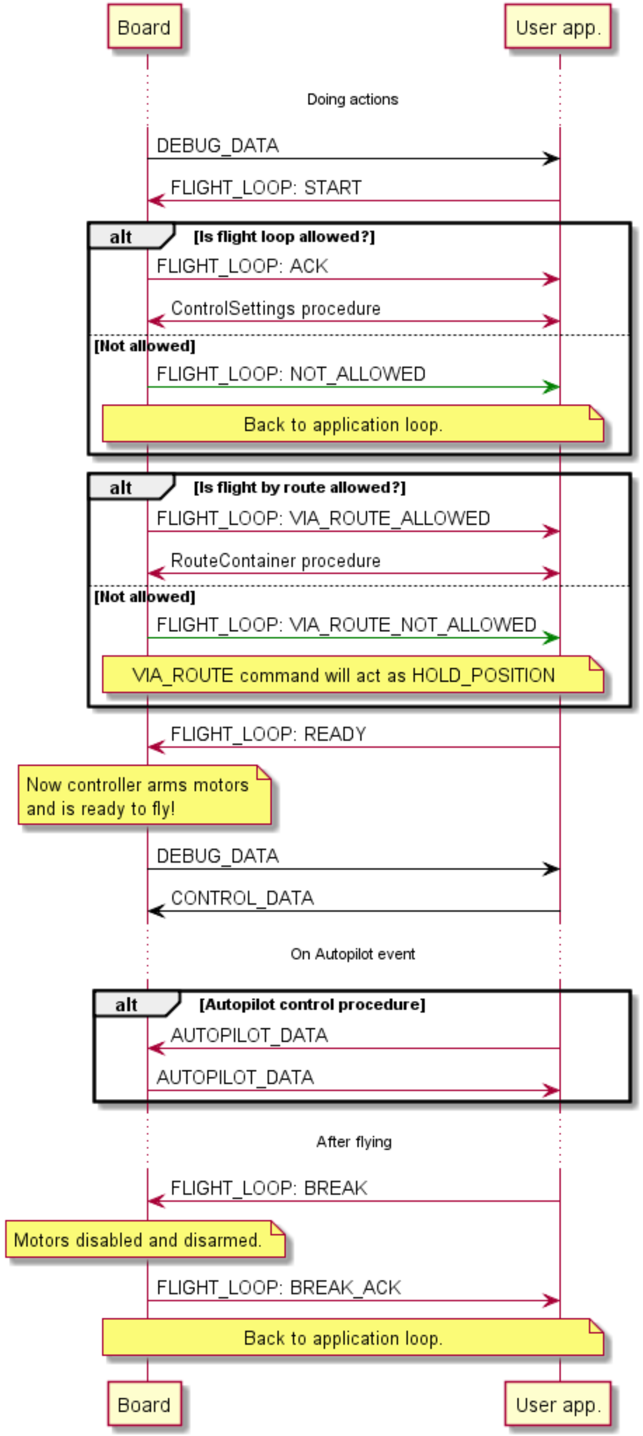
- Size: 8/58 bytes
- Configuration and synchronization
- Settings transmission
- TCP transport layer

Autopilot – {^, ^, ^, 0}

- Size: 32 bytes
- Position management in autopilot mode
- Autopilot events
- TCP transport layer

Communication protocol

- Can be transmitted over any binary interface
- Can be encapsulated in any IP layer
- Open source accessible from GitHub
  - [*https://github.com/skydiveuavs/skydive*](https://github.com/skydiveuavs/skydive)
- Wide documentation and use cases
- MIT license
- Allows to create your own application evolves drones powered by SkyDive controller board



Board

User app.

Doing actions

DEBUG_DATA

FLIGHT_LOOP: START

alt [Is flight loop allowed?]

FLIGHT_LOOP: ACK

ControlSettings procedure

[Not allowed]

FLIGHT_LOOP: NOT_ALLOWED

Back to application loop.

alt [Is flight by route allowed?]

FLIGHT_LOOP: VIA_ROUTE_ALLOWED

RouteContainer procedure

[Not allowed]

FLIGHT_LOOP: VIA_ROUTE_NOT_ALLOWED

VIA_ROUTE command will act as HOLD_POSITION

FLIGHT_LOOP: READY

Now controller arms motors
and is ready to fly!

DEBUG_DATA

CONTROL_DATA

On Autopilot event

alt [Autopilot control procedure]

AUTOPILOT_DATA

AUTOPILOT_DATA

After flying

FLIGHT_LOOP: BREAK

Motors disabled and disarmed.

FLIGHT_LOOP: BREAK_ACK

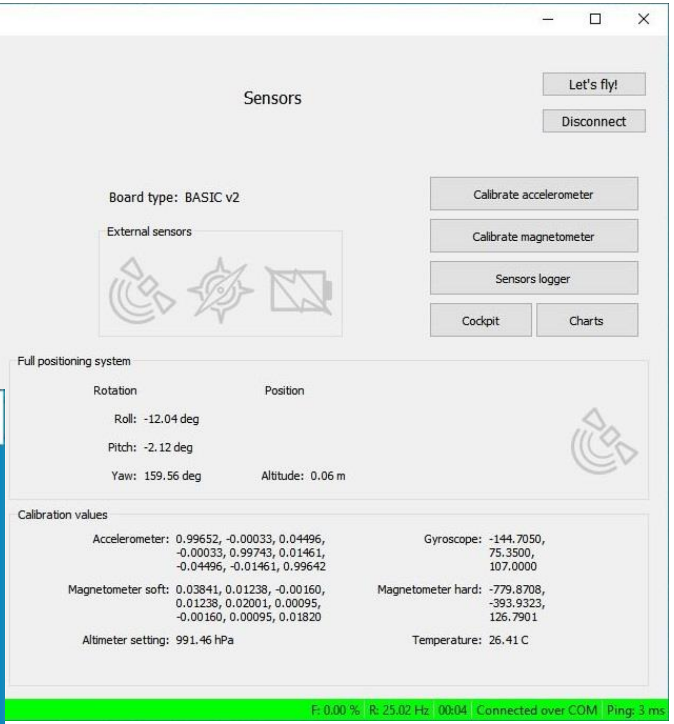
Back to application loop.

Board

User app.

User application - desktop

- C++ and QT implementation



SkyDive UAVs

Sensors

Board type: BASIC v2

External sensors

Full positioning system

Rotation

Roll: -12.04 deg

Pitch: -2.12 deg

Yaw: 159.56 deg

Position

Altitude: 0.06 m

Calibration values

Accelerometer: 0.99652, -0.00033, 0.04496, -0.00033, 0.99743, 0.01461, -0.04496, -0.01461, 0.99642

Gyroscope: -144.7050, 75.3500, 107.0000

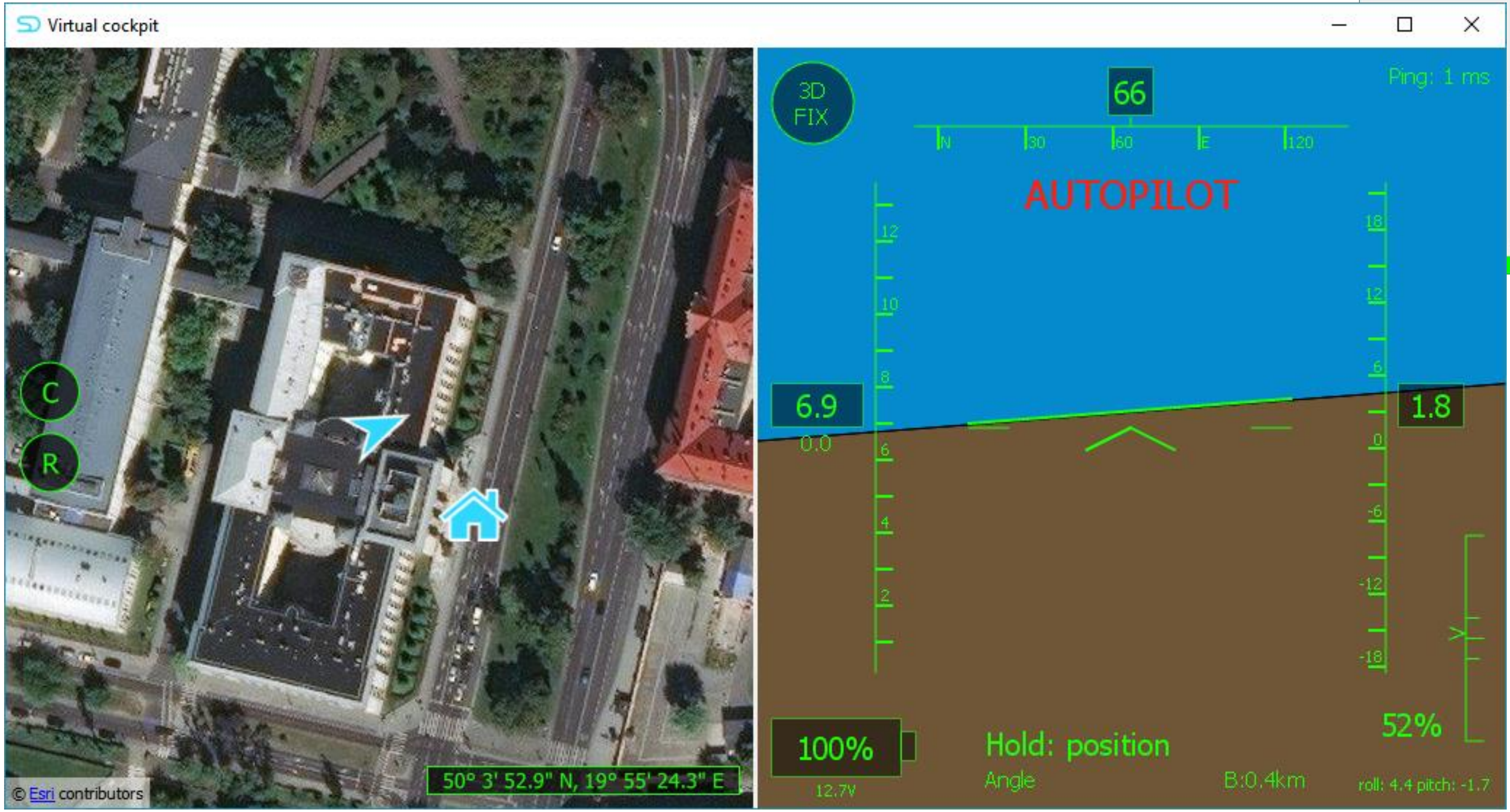
Magnetometer soft: 0.03841, 0.01238, -0.00160, 0.01238, 0.02001, 0.00095, -0.00160, 0.00095, 0.01820

Magnetometer hard: -779.8708, -393.9323, 126.7901

Altimeter setting: 991.46 hPa

Temperature: 26.41 C

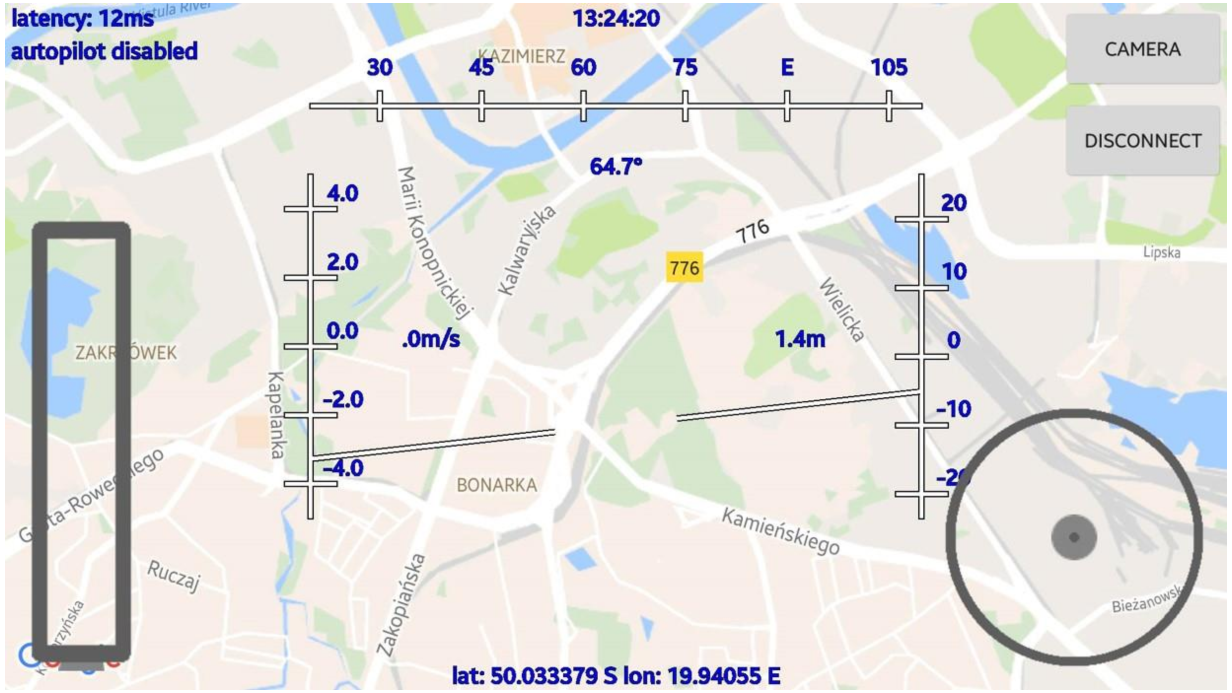
F: 0.00 % R: 25.02 Hz 00:04 Connected over COM Ping: 3 ms



Virtual cockpit

User application - mobile

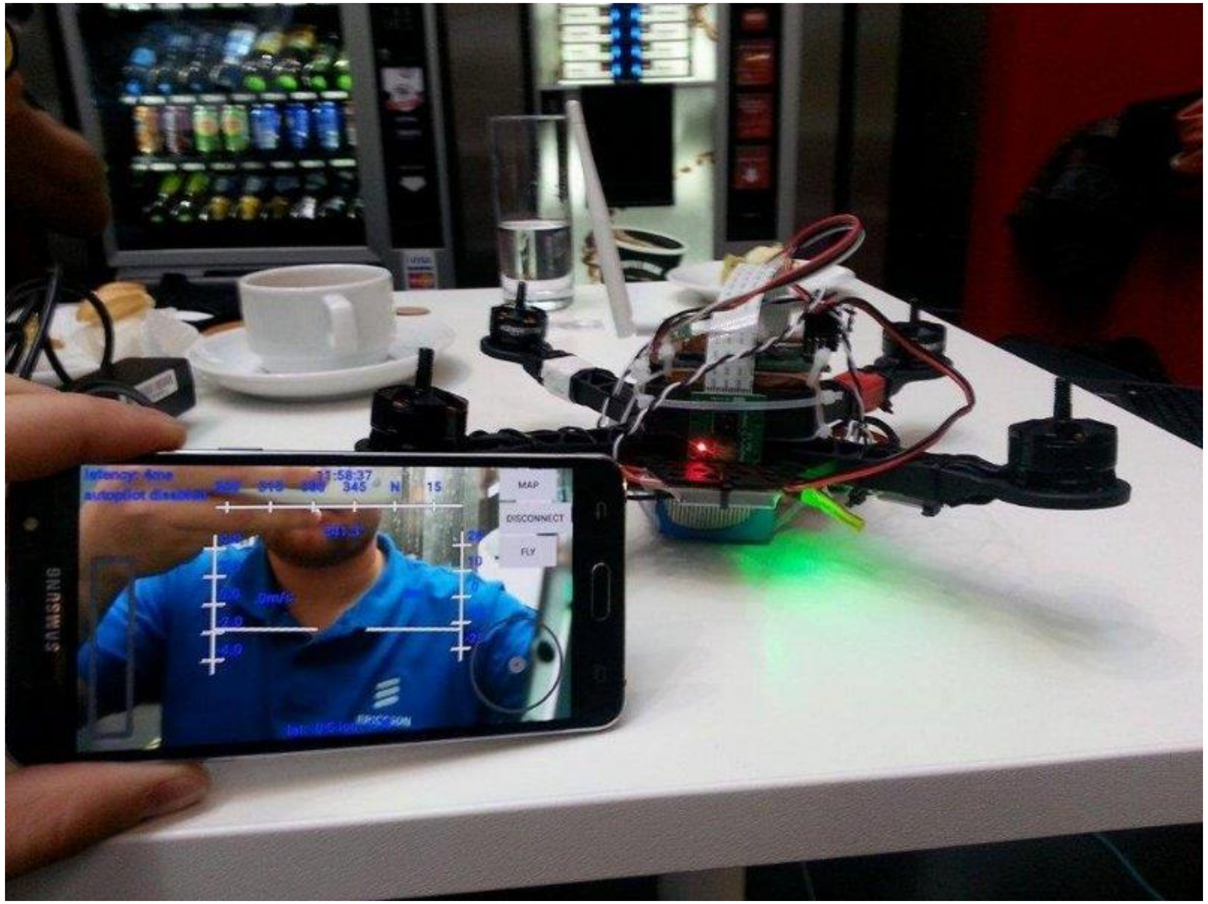
- https://github.com/nawbar23/AdDroneApplication
- WiFi interface (RB Pi2 vs. phone)



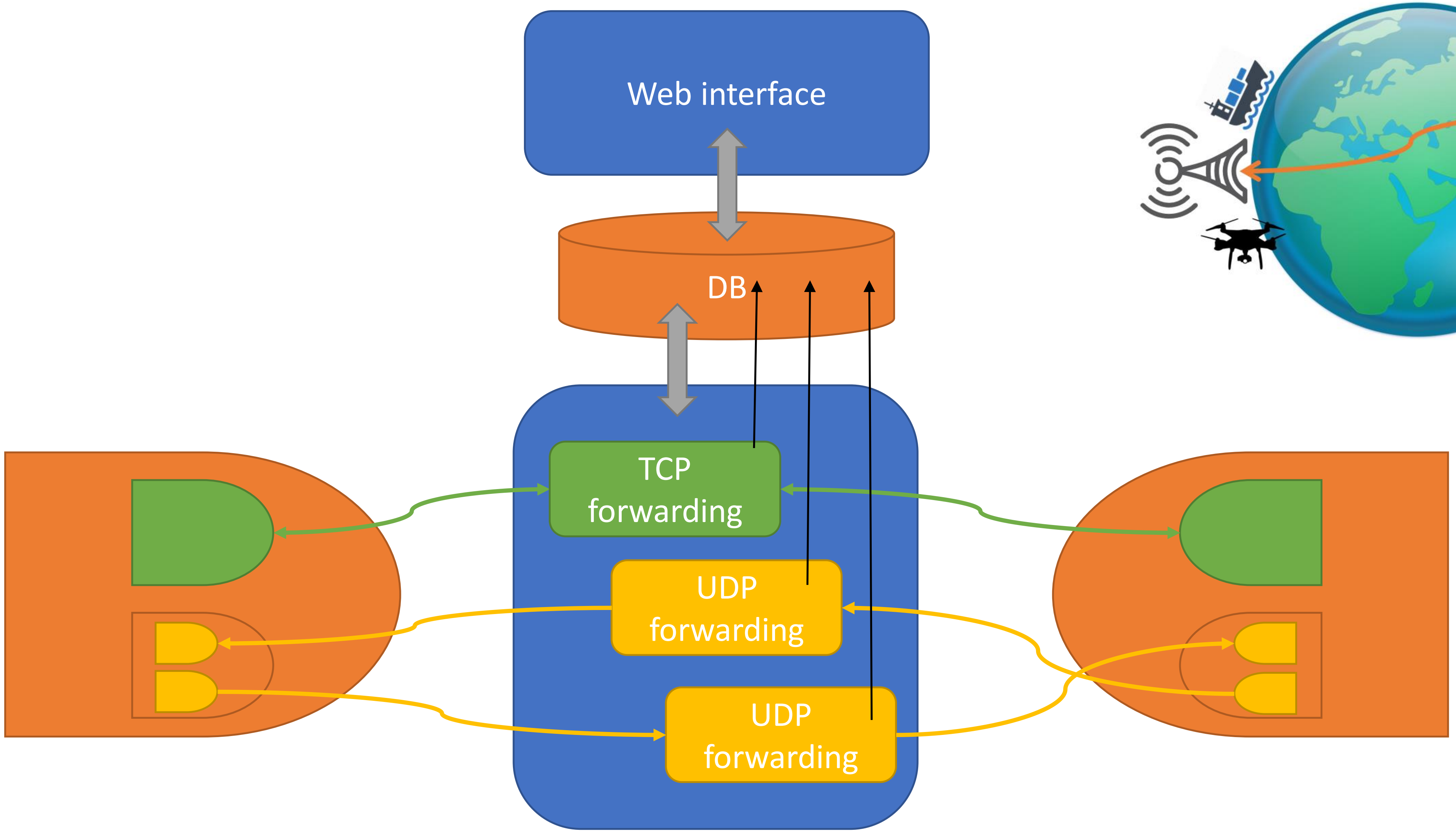
latency: 12ms
autopilot disabled

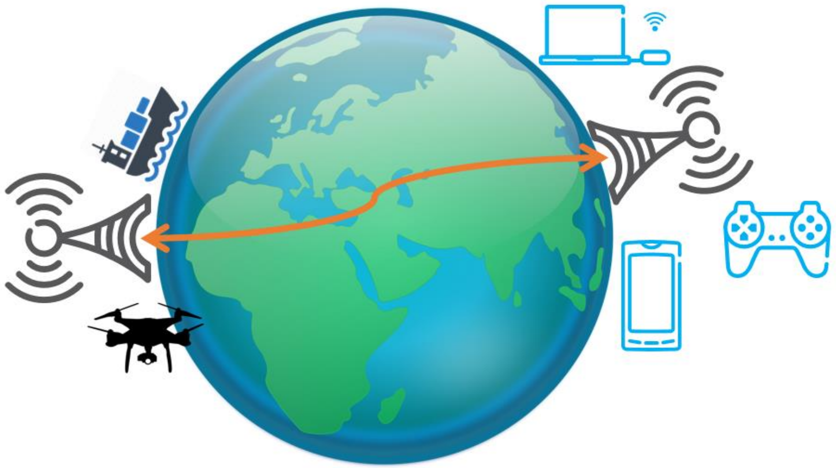
13:24:20

lat: 50.033379 S lon: 19.94055 E



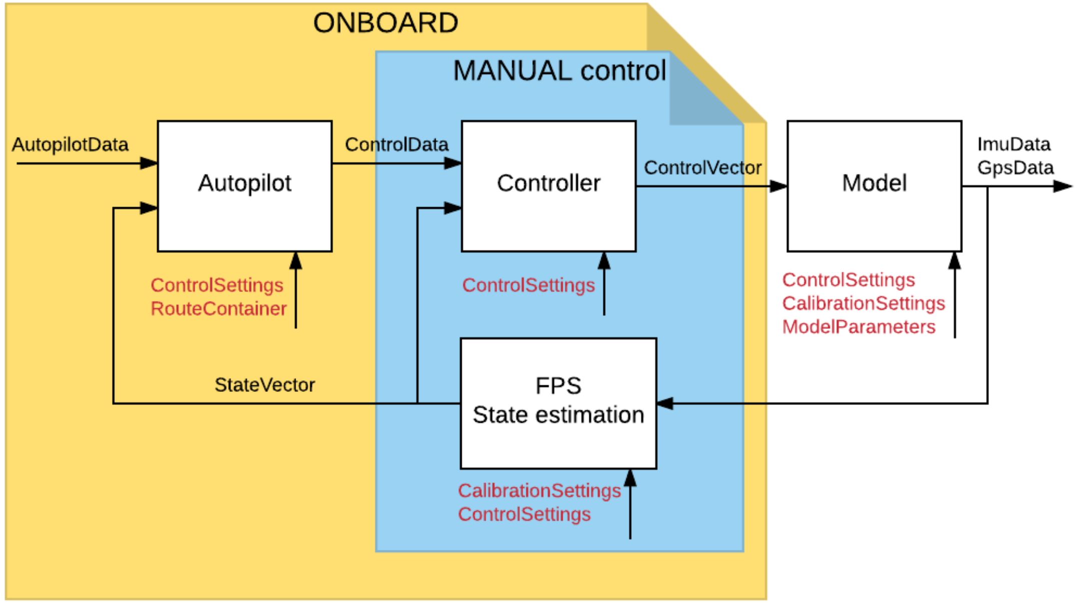
Drone over LTE – forwarding server

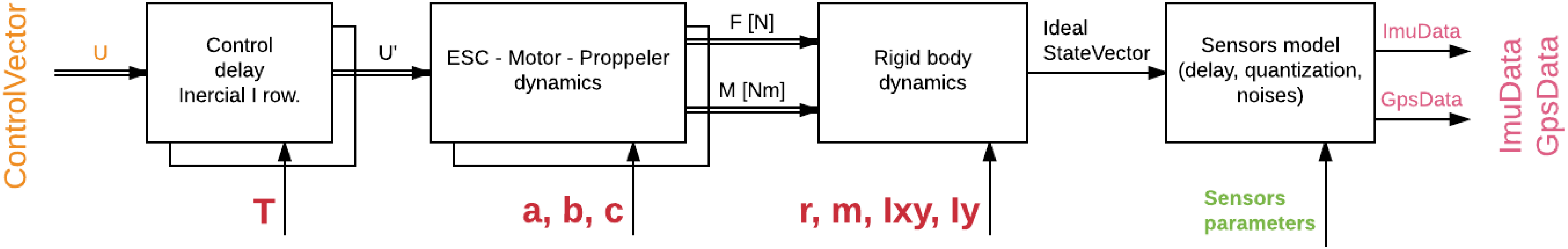




Test environment – legacy security

- Automated environment with most critical cases covered
- Tests based on multirotor model
- Model parameters identified in experiments





Test environment – flight simulator