5G RCID

5G Remote Controlled Inspection Drone

Sem van der Hoeven

ERICSSON

5G HUB CONNECTING NEW TECHNOLOGIES

avans 1hogeschool

Inhoud

- Context
- Overzicht drone
- Flight controller
- Flight computer
- Ontwerp
- Aansturing
- API
- Demo
- Aanbevelingen/reflectie

Context - Bedrijf

- Ericsson
- 5G Hub
- Demo’s

Context - Probleem

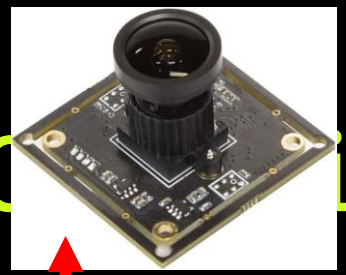
- 5G antenne inspecteren
  - Oxidatie
  - Swapped feeders
  - Line of Sight
- Inspecteren na monitoren
- Demo mogelijkheden 5G
  - BVLOS (Beyond Visual Line of Sight)
- Onderdelen drone
  - Voorafgaand aan project besteld

Context - Hoofdvraag

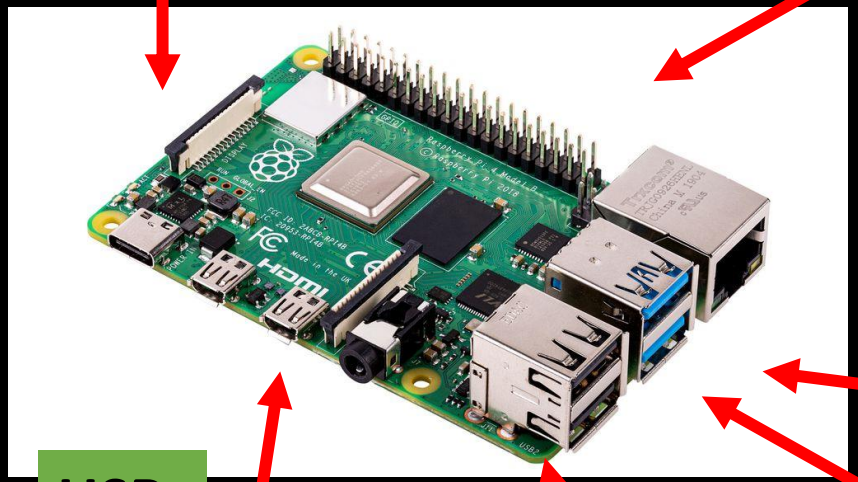
- *Hoe kan een drone ontwikkeld worden die met 5G aangestuurd kan worden om zo op afstand autonoom inspecties uit te voeren?*

- Hoe kunnen de Raspberry Pi flight computer en PixHawk 4 Mini flight controller gebruikt worden om de drone te laten vliegen?
- Waar zit de intelligentie van de drone die de onderdelen samen laat werken?
- Hoe kan de drone op afstand via 5G bestuurd worden?
- Welke 5G-technologieën zijn nodig om de drone succesvol inspecties uit te laten voeren?

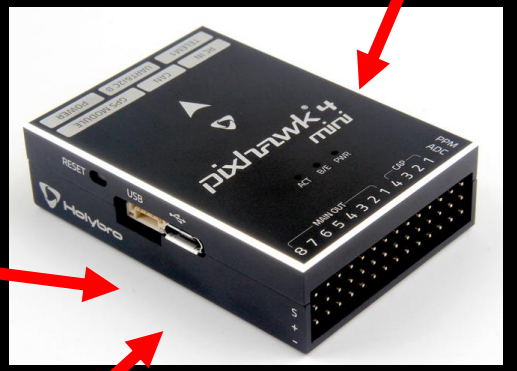
Overzicht onderdelen drone



USB C



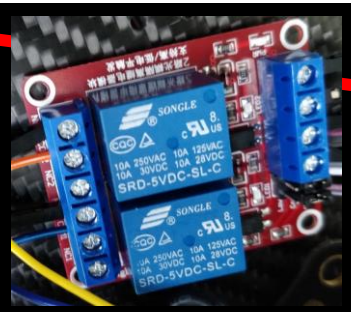
MAVLINK
MICRO AIR VEHICLE COMMUNICATION PROTOCOL



USB

USB

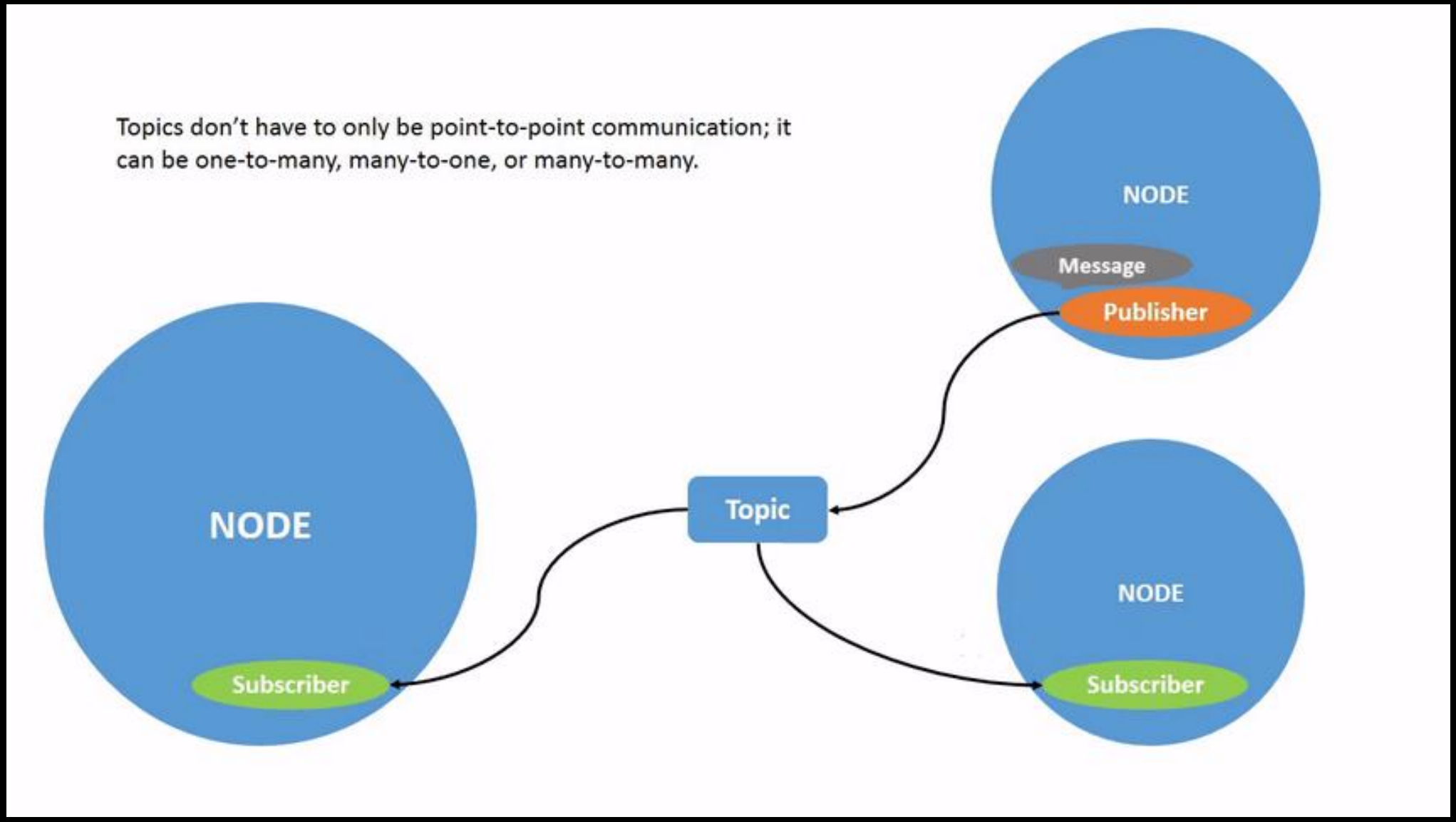
GPIO



Flight controller

- Doel - drone laten vliegen
- Autopilot software
  - ArduPilot
  - PX4
- ROS (Robot Operating System)
  - ArduPilot
    - MAVROS (ROS 1)
  - PX4
    - MAVROS (ROS 1)
    - PX4 ROS 2 Bridge
      - XRCE-DDS
      - Beta v1.14

ROS

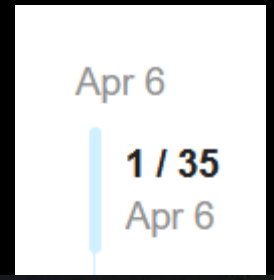

Topics don't have to only be point-to-point communication; it can be one-to-many, many-to-one, or many-to-many.
NODE
Message
Publisher
NODE
Subscriber
Topic
NODE
Subscriber

Flight computer

- Doel – Aansturen flight controller
  - Uitlezen sensoren
  - Verbinding API
- Raspberry Pi 4B+
  - 2GB -> 8GB
- OS
  - Ubuntu Linux
    - ROS 1
    - ROS 2
  - Raspberry Pi OS
    - ROS 1
    - ROS 2 met Docker

Verbinding flight computer – flight controller

- PX4 ROS 2 Bridge
- Veel problemen
  - Bouwen packages, hardware dependencies




```
[Processing: px4_ros_com] [2h 25min 36.7s] [2/3 complete] [px4_ros_com:build 4% - 2h 24min 22.0s]
[Processing: px4_ros_com] [2h 31min 42.6s] [2/3 complete] [px4_ros_com:build 4% - 2h 30min 27.8s]

[Processing: px4_ros_com] [2h 42min 26.1s] [2/3 complete] [px4_ros_com:build 4% - 2h 41min 11.3s]
[Processing: px4_ros_com] [2h 48min 38.3s] [2/3 complete] [px4_ros_com:build 4% - 2h 47min 23.5s]
[Processing: px4_ros_com]
[Processing: px4_ros_com] [2h 54min 29.3s] [2/3 complete] [px4_ros_com:build 4% - 2h 53min 14.6s]
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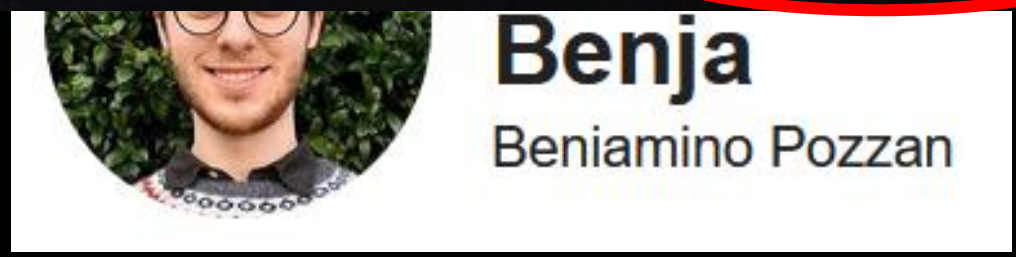
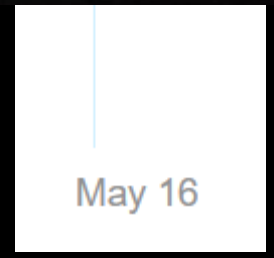
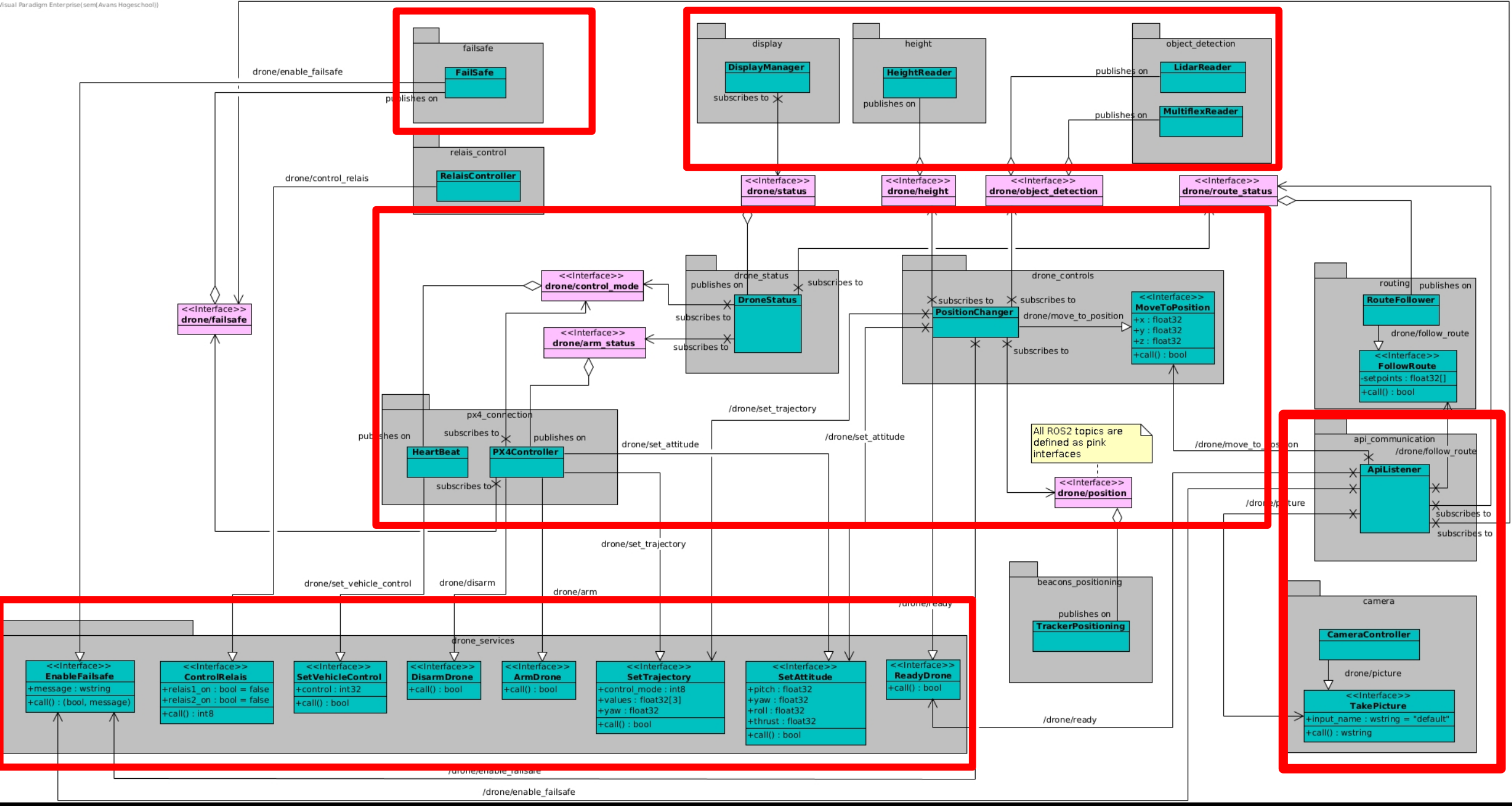
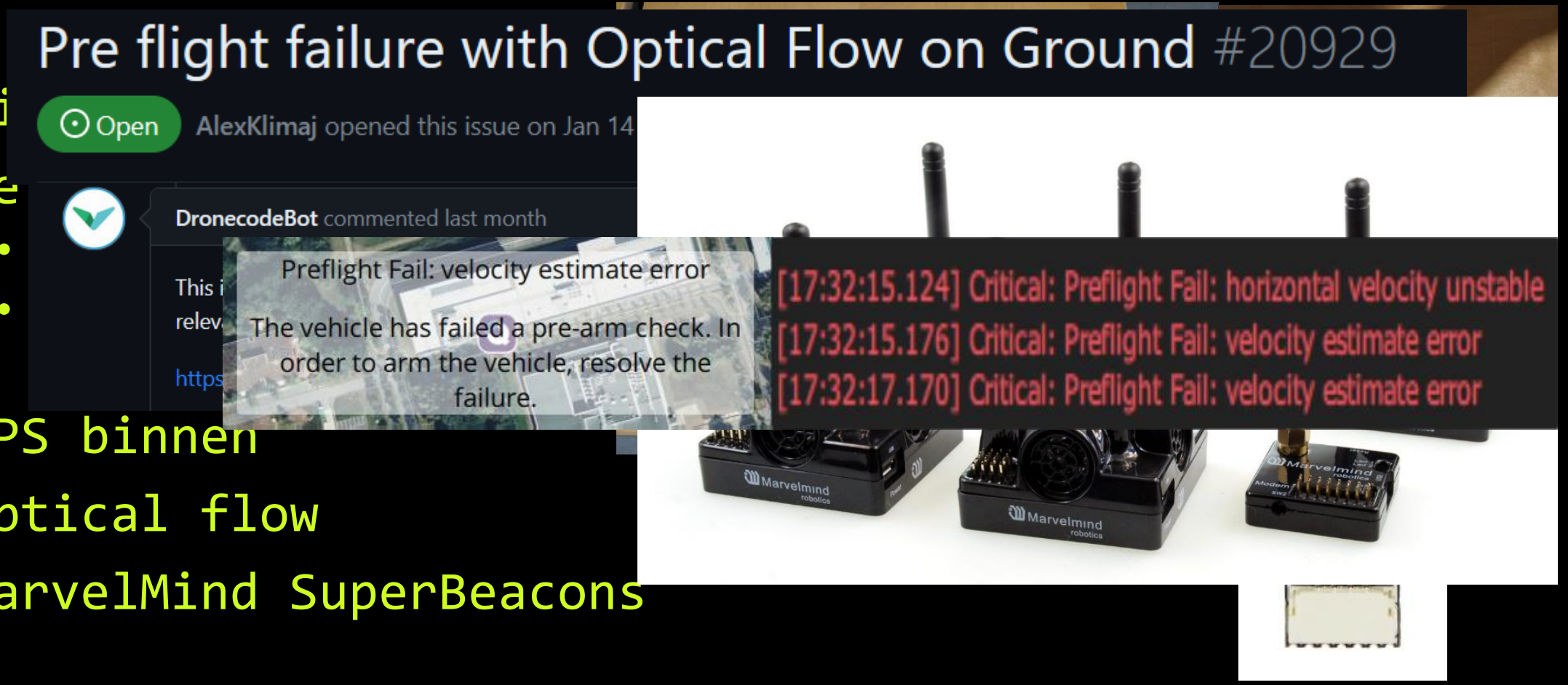





failsafe
FailSafe
drone/enable_failsafe
publishes on
display
DisplayManager
subscribes to
height
HeightReader
publishes on
object_detection
publishes on
LidarReader
publishes on
MultiflexReader
relais_control
RelaisController
drone/control_relais
<<Interface>>
drone/status
<<Interface>>
drone/height
<<Interface>>
drone/object_detection
<<Interface>>
drone/route_status
<<Interface>>
drone/failsafe
<<Interface>>
drone/control_mode
drone_status
publishes on
subscribes to
DroneStatus
subscribes to
<<Interface>>
drone/arm_status
subscribes to
drone_controls
subscribes to
subscribes to
PositionChanger
drone/move_to_position
<<Interface>>
MoveToPosition
+x : float32
+y : float32
+z : float32
+call() : bool
subscribes to
routing
publishes on
RouteFollower
drone/follow_route
<<Interface>>
FollowRoute
-setpoints : float32[]
+call() : bool
px4_connection
publishes on
subscribes to
publishes on
HeartBeat
PX4Controller
subscribes to
drone/set_attitude
/drone/set_trajectory
/drone/set_attitude
All ROS2 topics are defined as pink interfaces
<<Interface>>
drone/position
/drone/move_to_position
api_communication
/drone/follow_route
ApiListener
subscribes to
subscribes to
/drone/picture
beacons_positioning
publishes on
TrackerPositioning
drone/set_trajectory
drone/set_vehicle_control
drone/disarm
drone/arm
/drone/ready
camera
CameraController
drone/picture
<<Interface>>
TakePicture
+input_name : wstring = "default"
+call() : wstring
drone_services
<<Interface>>
EnableFailsafe
+message : wstring
+call() : (bool, message)
<<Interface>>
ControlRelais
+relais1_on : bool = false
+relais2_on : bool = false
+call() : int8
<<Interface>>
SetVehicleControl
+control : int32
+call() : bool
<<Interface>>
DisarmDrone
+call() : bool
<<Interface>>
ArmDrone
+call() : bool
<<Interface>>
SetTrajectory
+control_mode : int8
+values : float32[3]
+yaw : float32
+call() : bool
<<Interface>>
SetAttitude
+pitch : float32
+yaw : float32
+roll : float32
+thrust : float32
+call() : bool
<<Interface>>
ReadyDrone
+call() : bool
/drone/ready
/drone/enable_failsafe
/drone/enable_failsafe

Aansturing

- Ni
- Se
  -
  -
- GPS binnen
- Optical flow
- MarvelMind SuperBeacons



5G Drone API

5G Drone API

Camera view: Not connected

Take picture

Arm/Disarm

Not connected to drone

Connect

Controls

Turn left | Turn right | Up | Down | Forward | Backward | Left | Right | Land | **Emergency Stop**

Last picture:

Drone status

Battery percentage

CPU load

Current speed

Current position

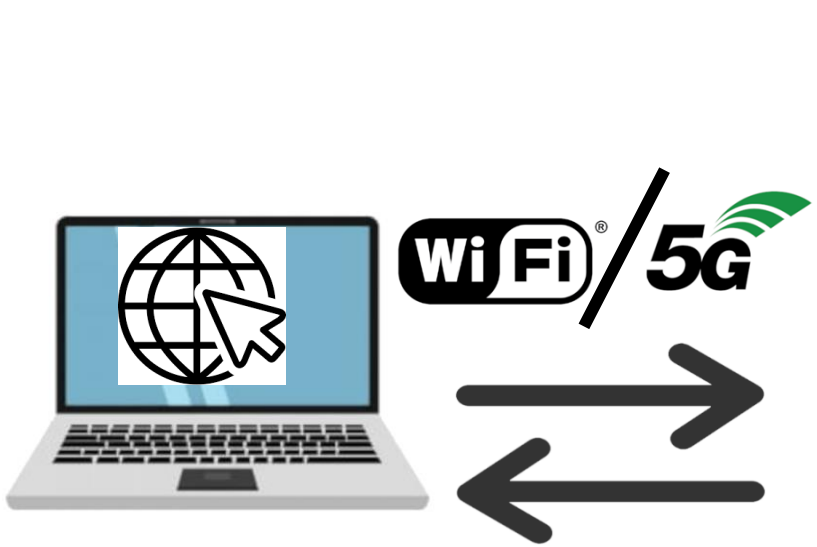
Height

Failsafe not activated

ERICSSON

5G HUB
CONNECTING NEW TECHNOLOGIES

Overzicht verbinding



Demo

- API
- Vliegen drone (video)

Aanbevelingen

- 3D printen guards propellers
  - PDC voor frame?

- Flight computer met sterkere processor
- 3D printen onderdelen
  - Mount camera, mount flight computer en modem, pootje
- Uitbreiden autonoom vliegen

Reflectie

- Heel veel geleerd
  - Vanaf 0 naar een vliegende drone
- Werkend product waar Ericsson verder mee kan