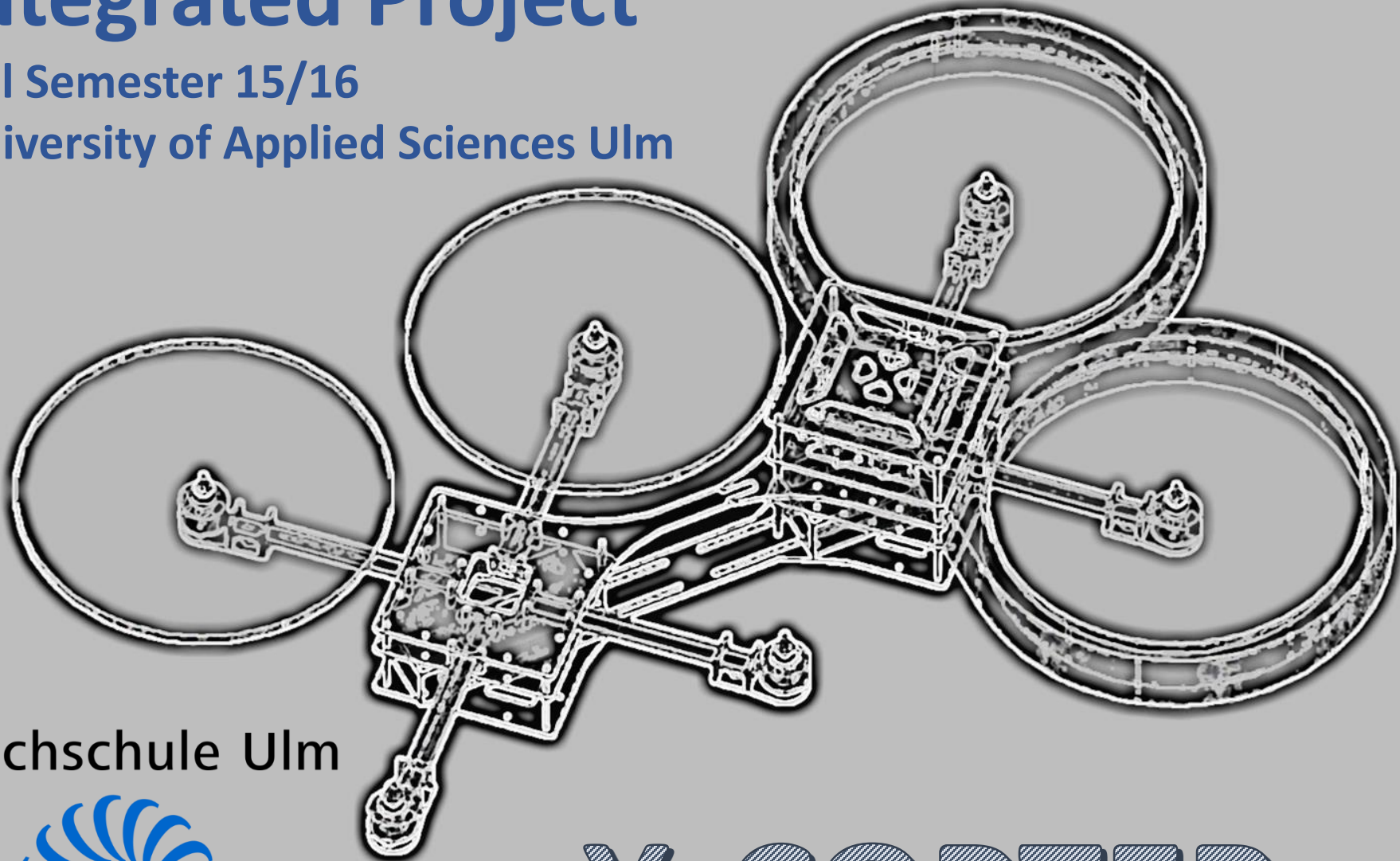


Integrated Project

Fall Semester 15/16

University of Applied Sciences Ulm



Hochschule Ulm



X-COPTER



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- Overview
- Project Management
- System Architecture
- Hardware
- Linux
- Flight Controller
- Challenges
- Lessons Learned

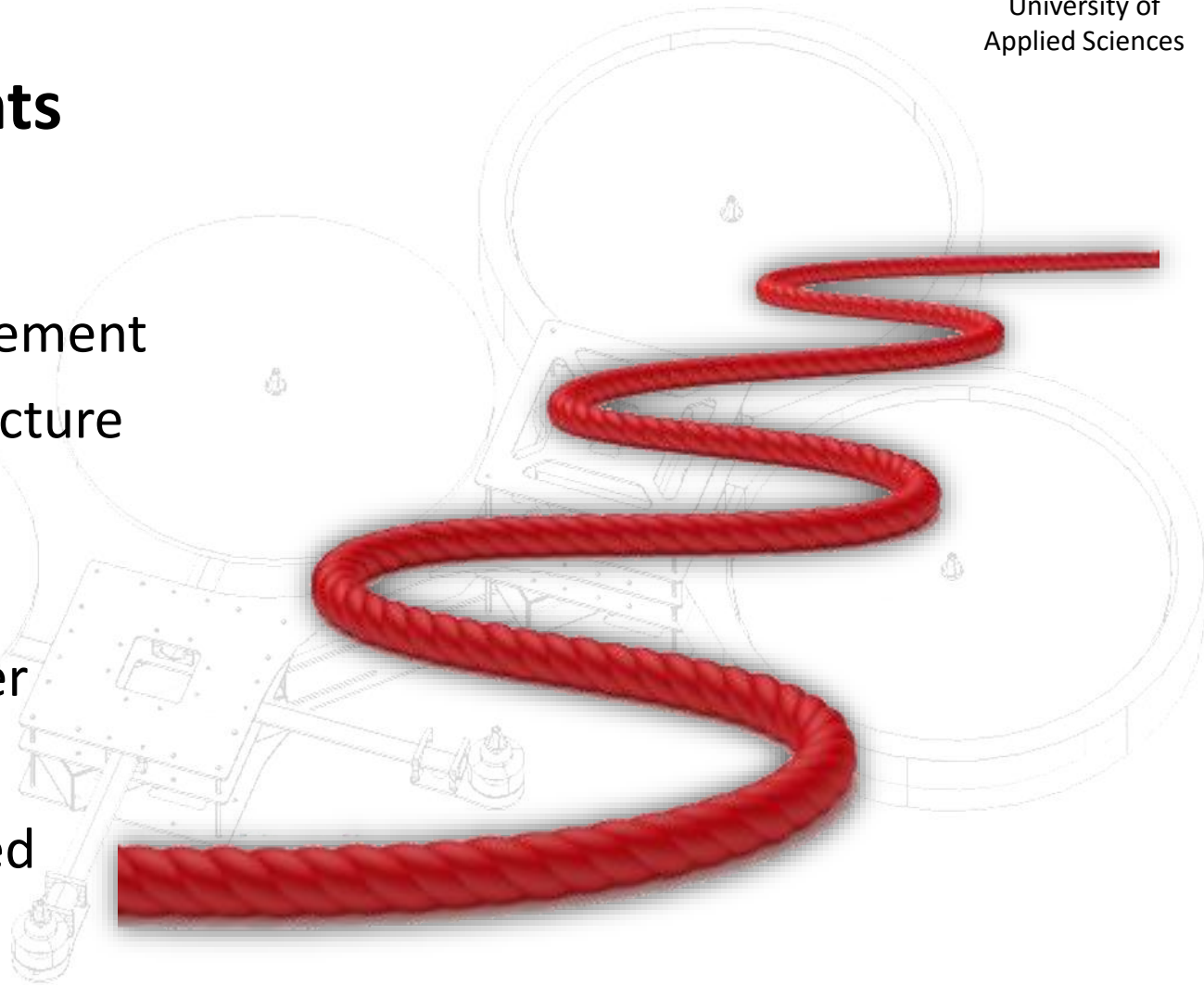




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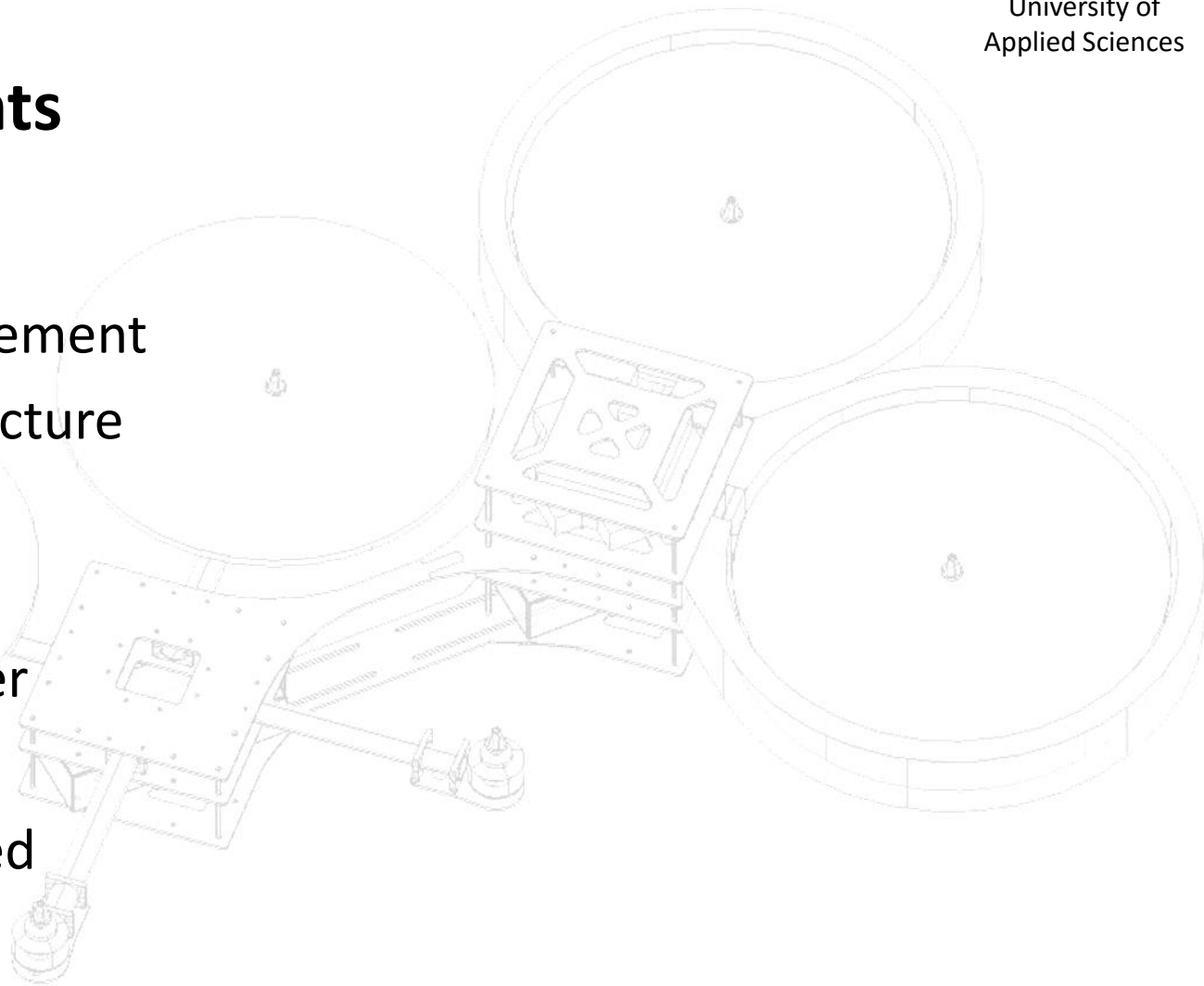
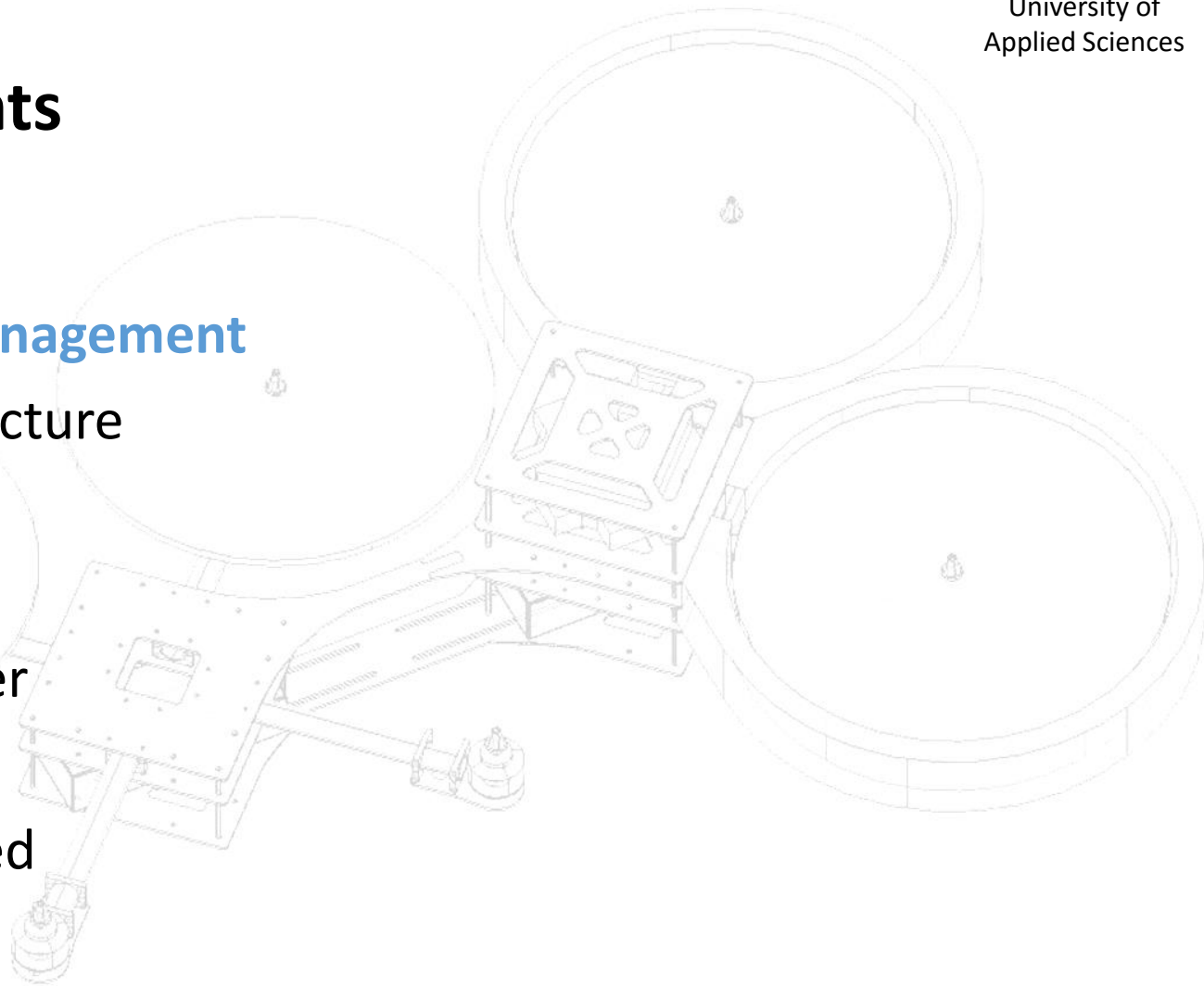




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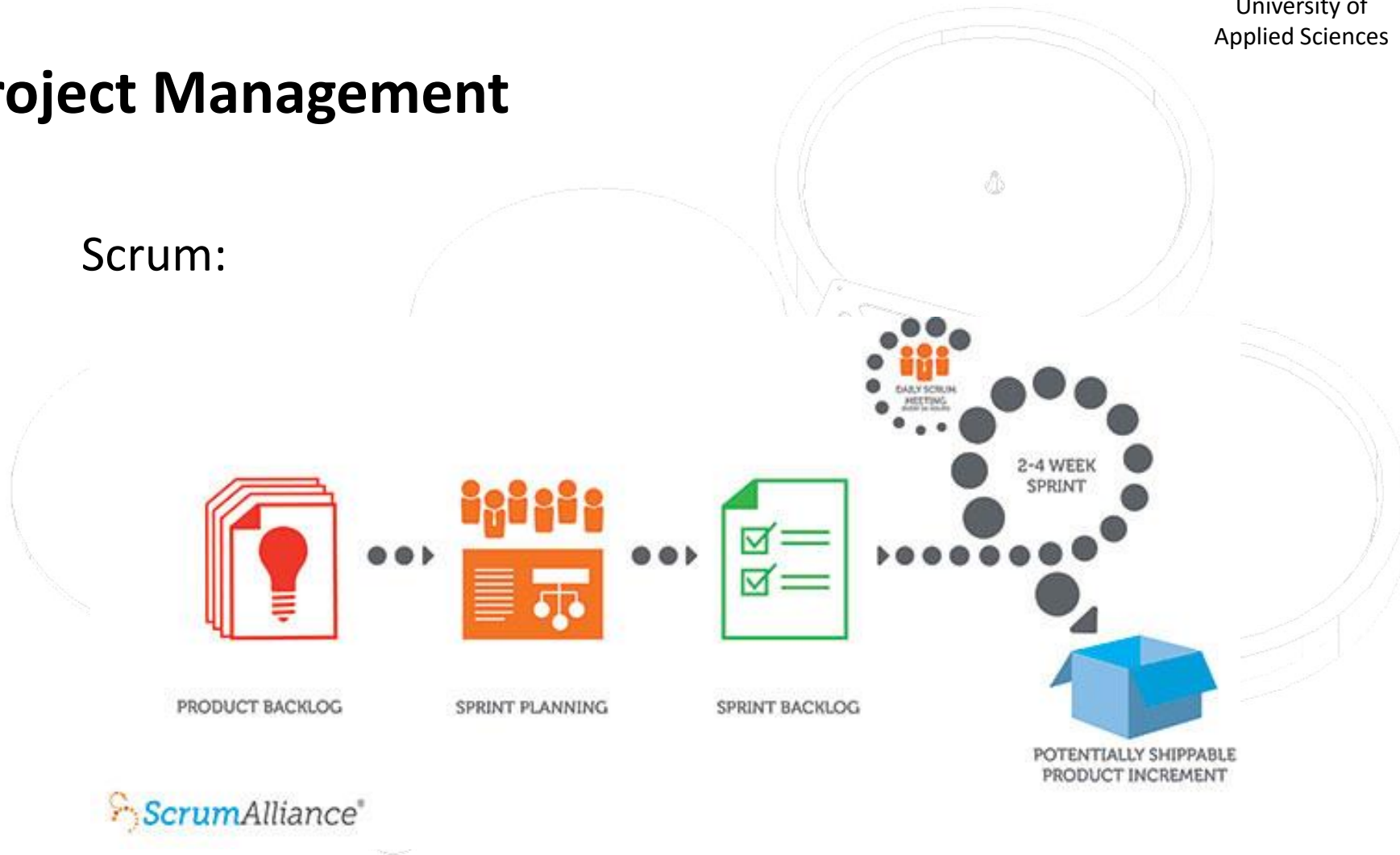
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Project Management

Scrum:





Change Project Management

Scrum:

Positive	Negative
Daily Scrum	Sprint Planning
Taskboard	Sprint Review
	Sprint Retrospektive

Result: Scrum only works if the team meets every day



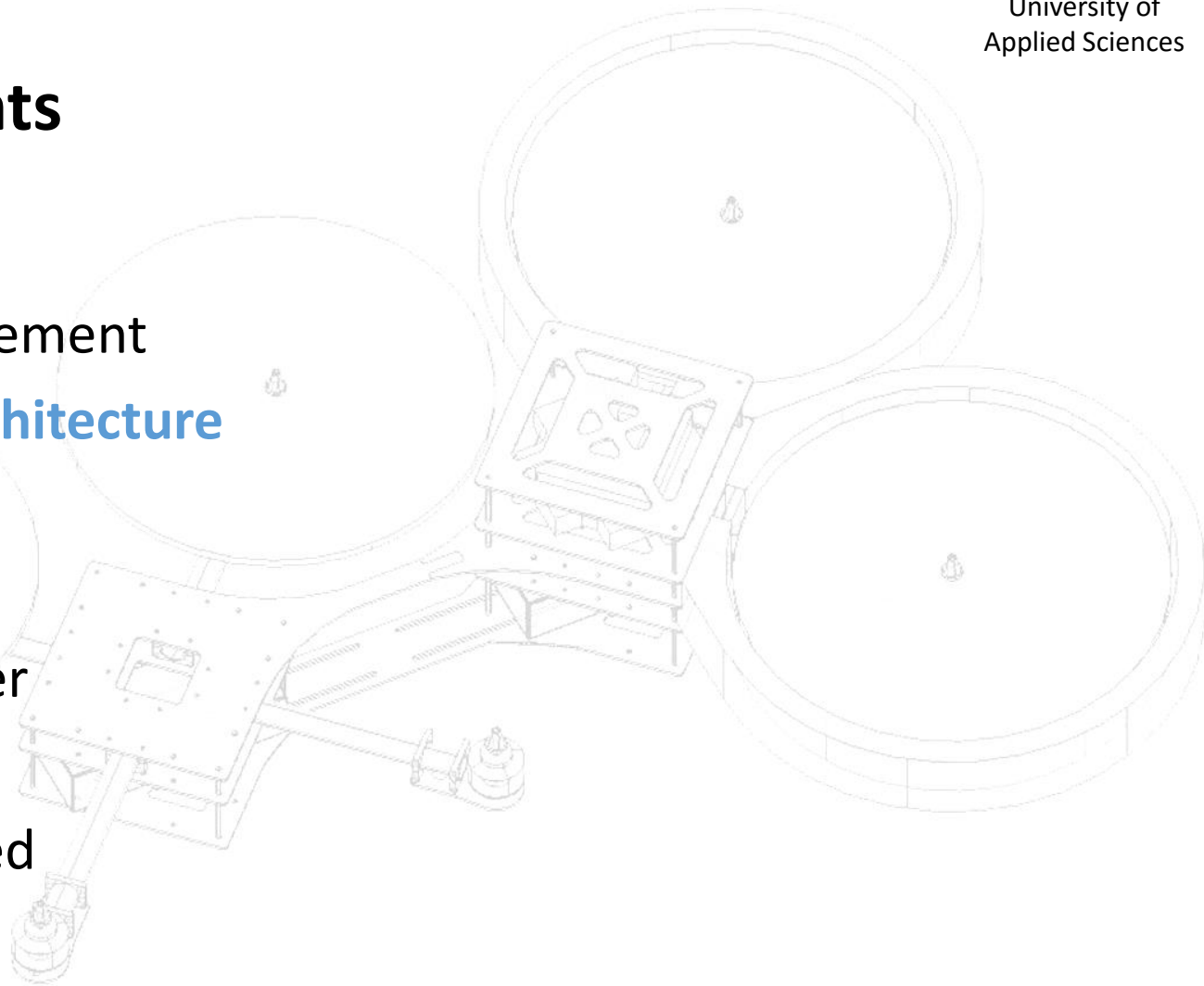
Flight test of the model:





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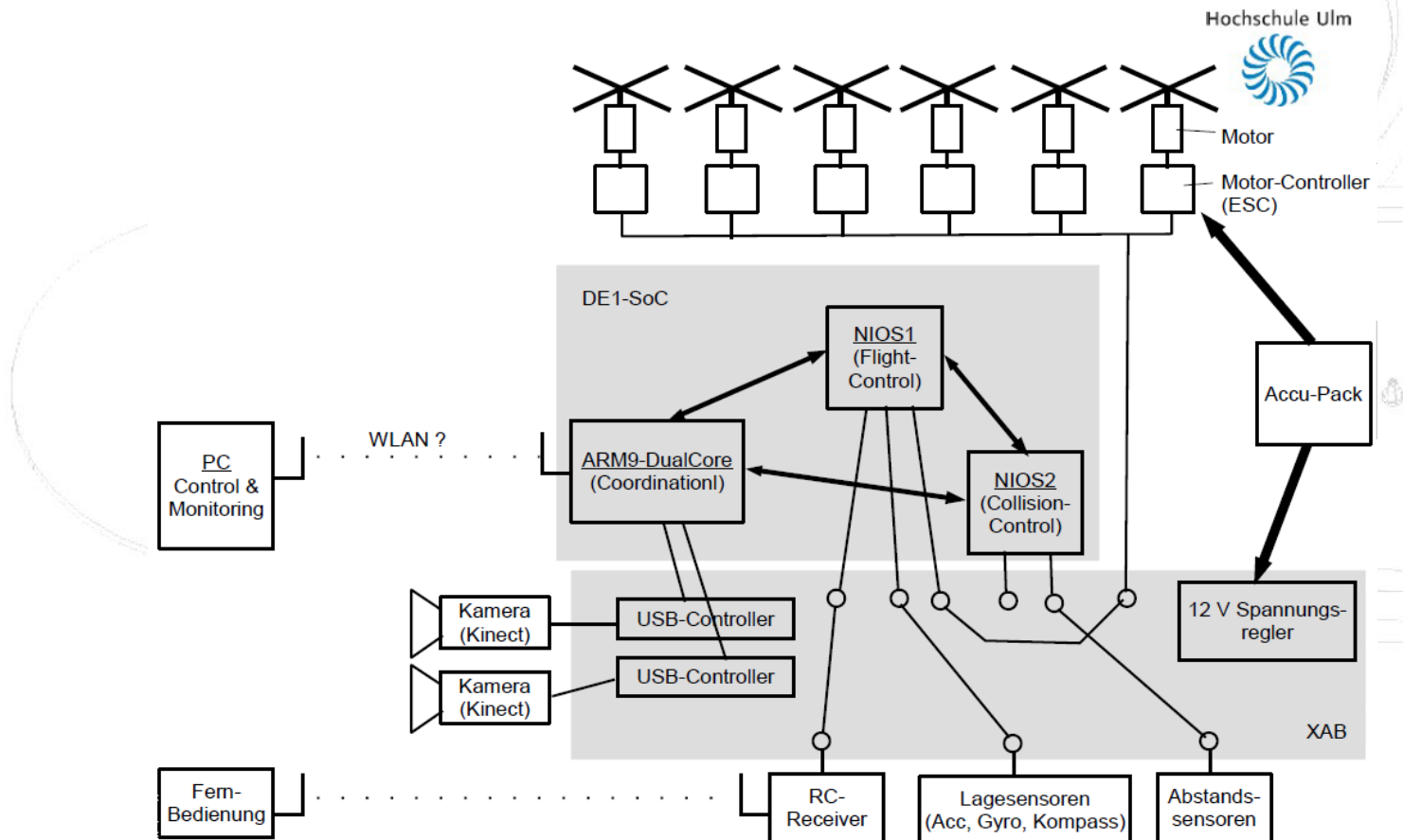
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The X-Copter Project: System Architecture

Old System Architecture





The X-Copter Project: System Architecture

New System Architecture

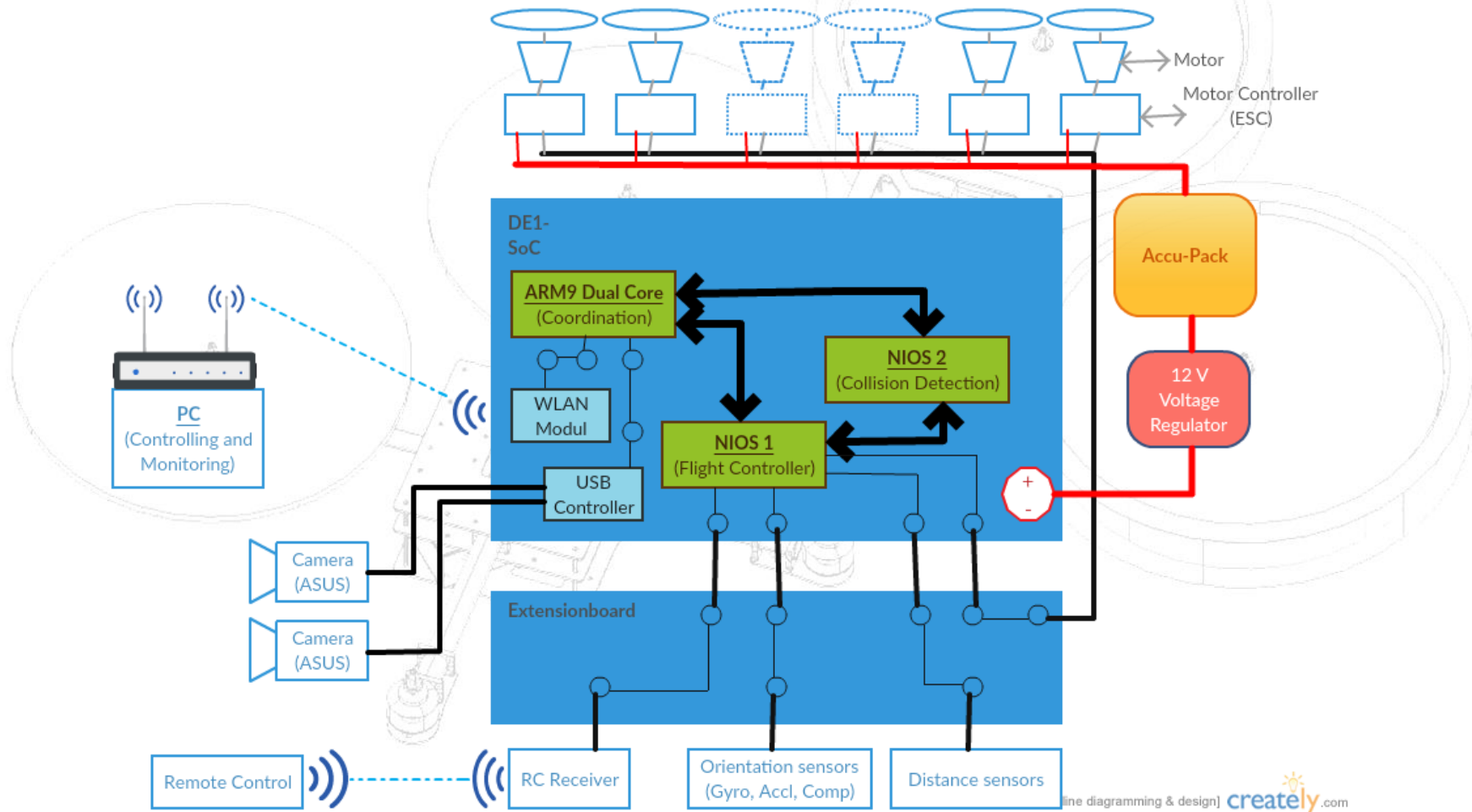
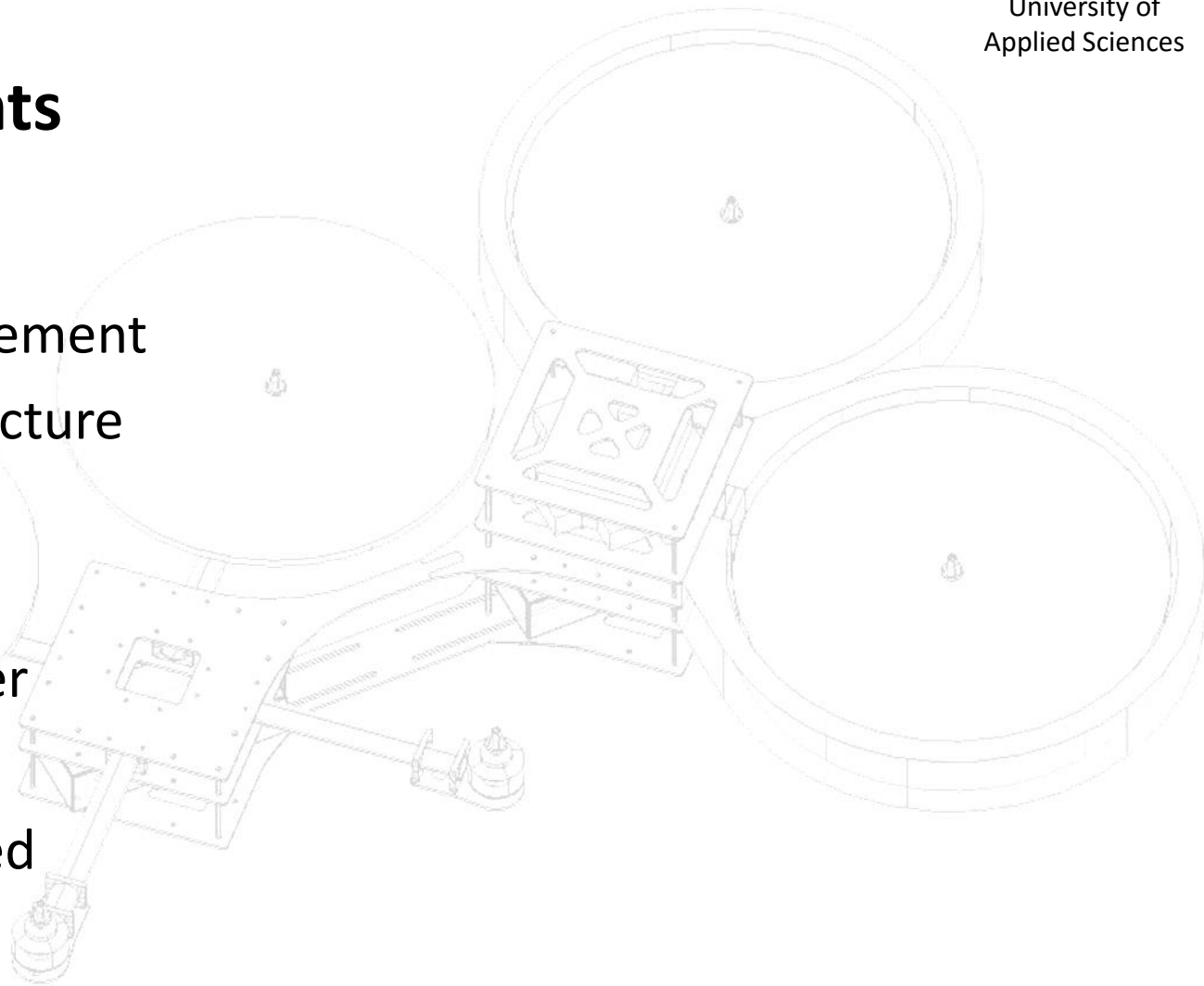




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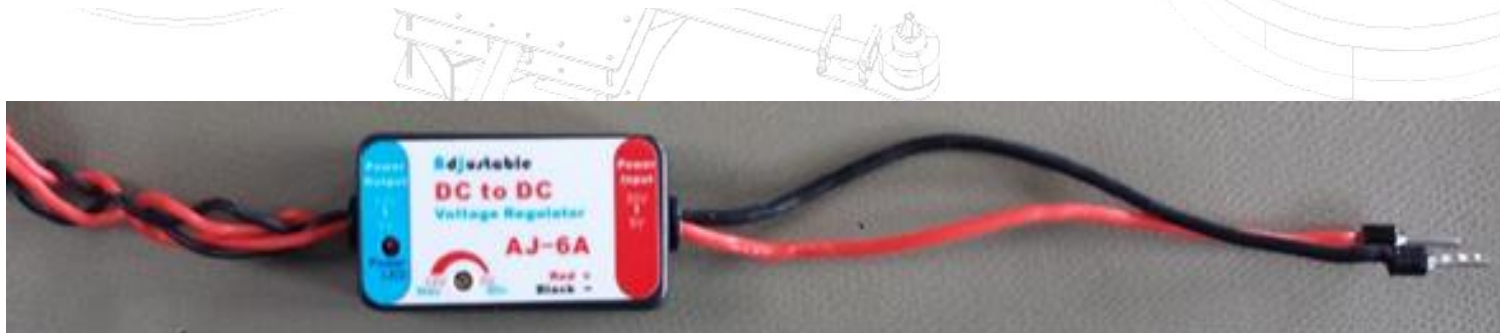
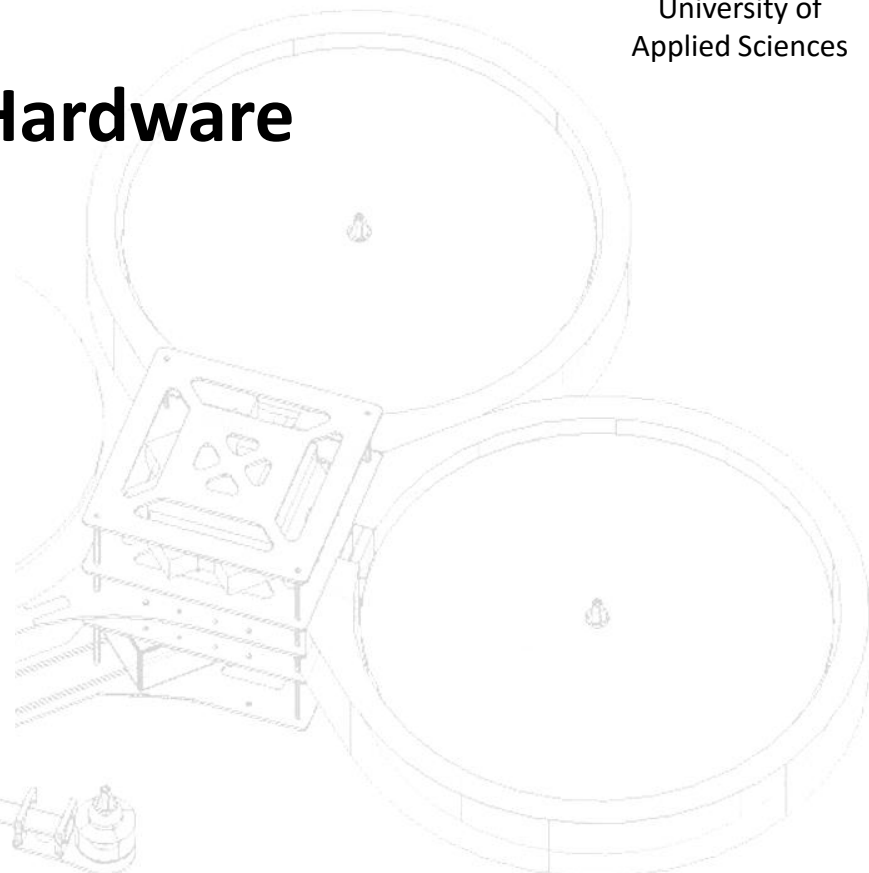
Additional Flight controller Hardware

Commercial powersupply

- 5-30 Vin
- 5-12Vout
- max 6A output

Graupner MX-16 RC transmitter

Gr-16 2.4 GHz RC receiver



RC Receiver

Graupner MX-16 HoTT Transmitter
GR-16 2.4 GHz Receiver supporting

- Sum signal (PPM)
- Serial sum signal

Support for telemetry data





Graupner SUMD protocol

- Compatible with UART port
- Updating every 10ms
- 16bit output resolution
- Fairly easy to implement
- In contrast to PPM no real-time encoding required.

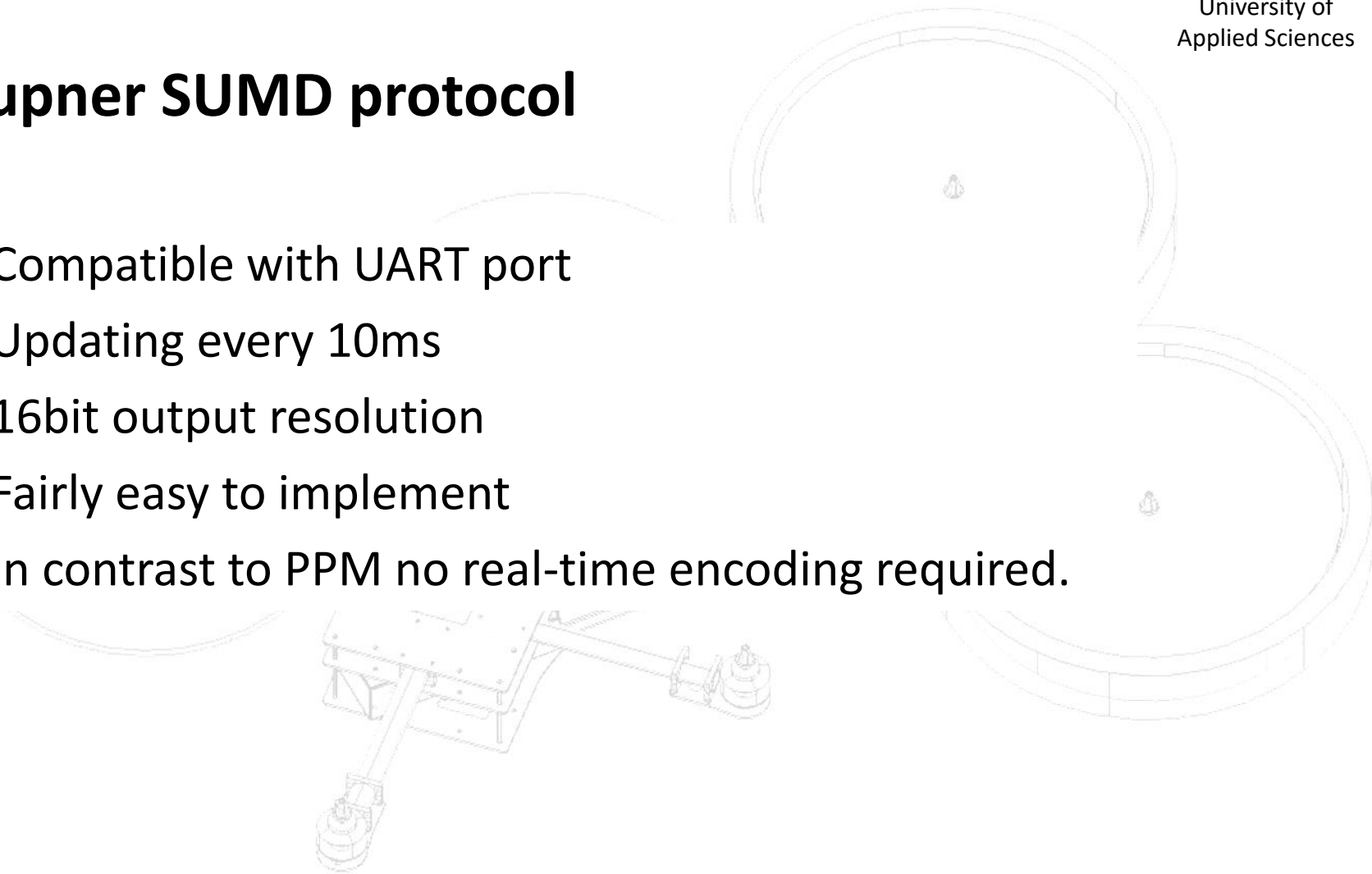
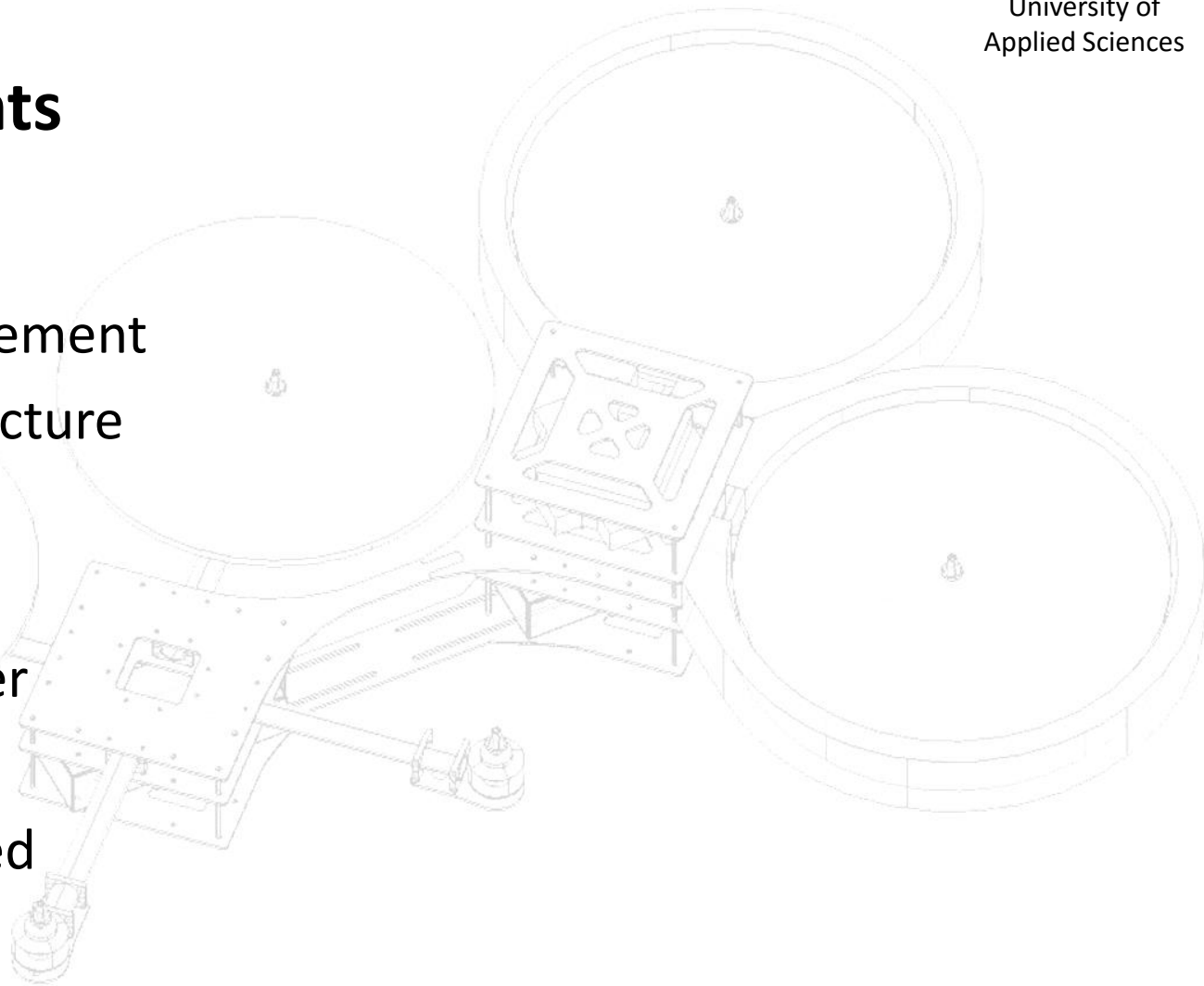




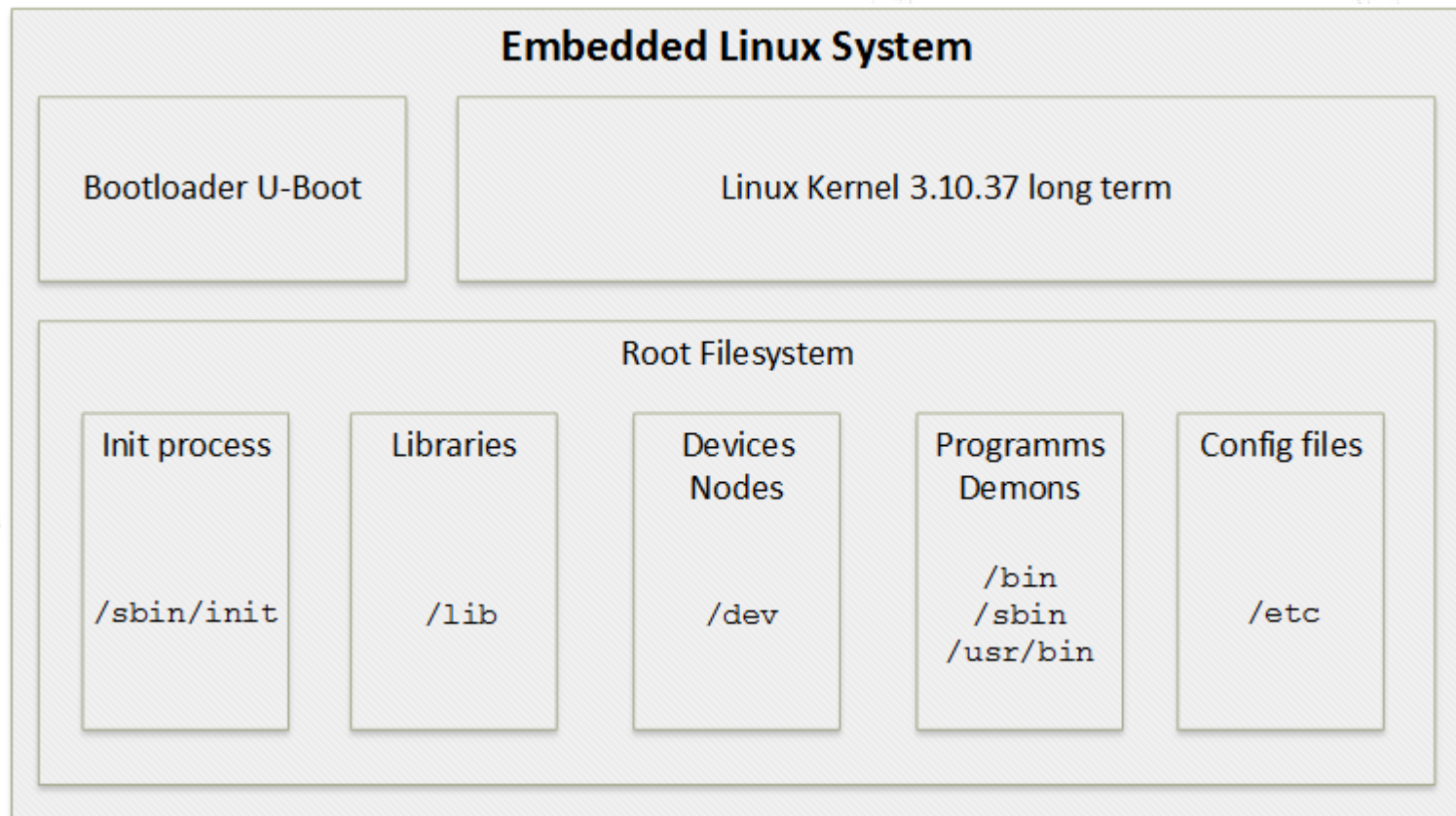
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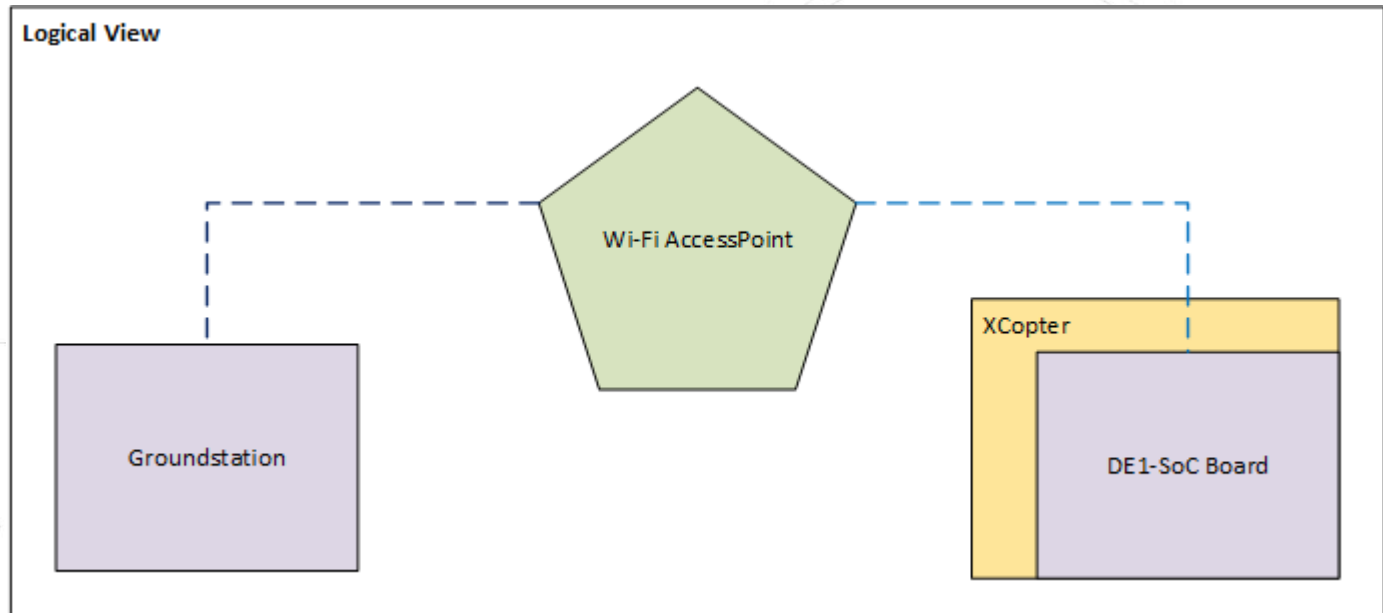


Buildroot





Wi-Fi

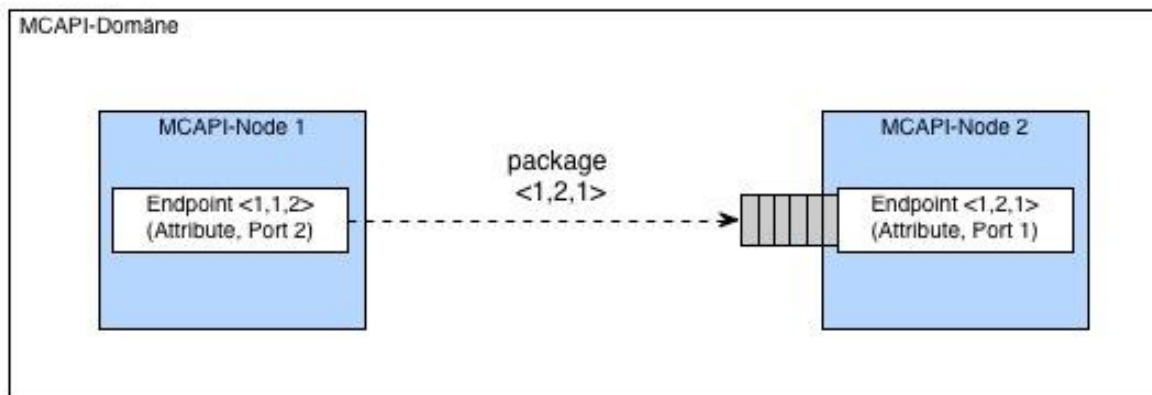
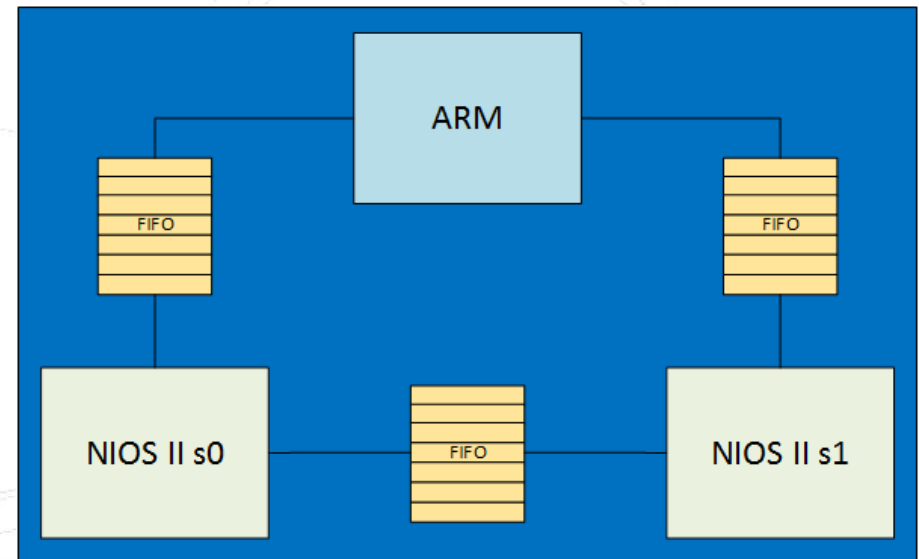


- Automatically Connection at start up
- Stable link to access point
- Encrypted communication with WPA2



MCAPI

- Interprocessor communication
- FIFO based





The X-Copter Project: Linux

MAVLink

Micro Air Vehicle Communication Protocol

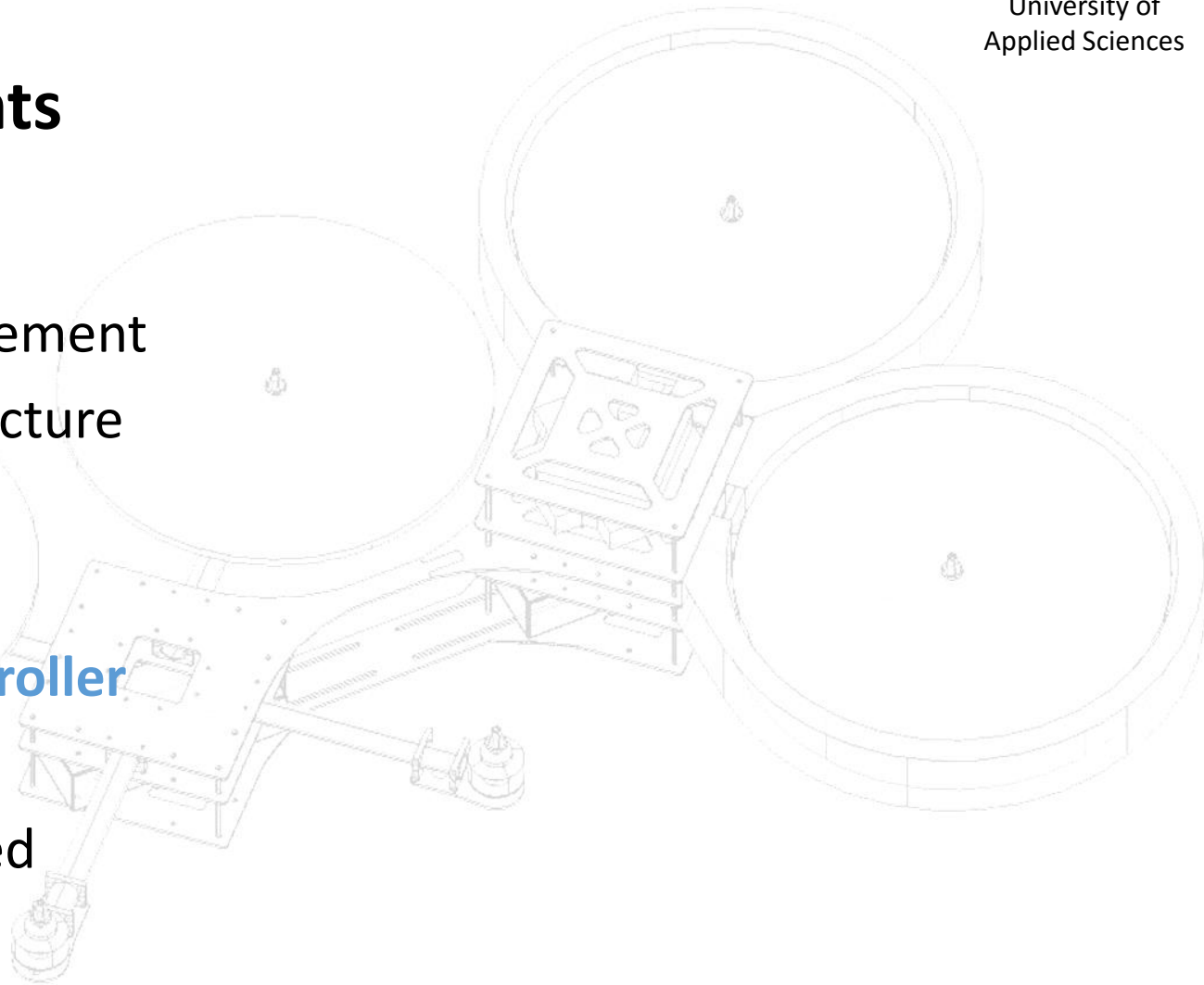
- Communication protocol between UAV and ground station
- C library for header based messaging
- QGroundControl





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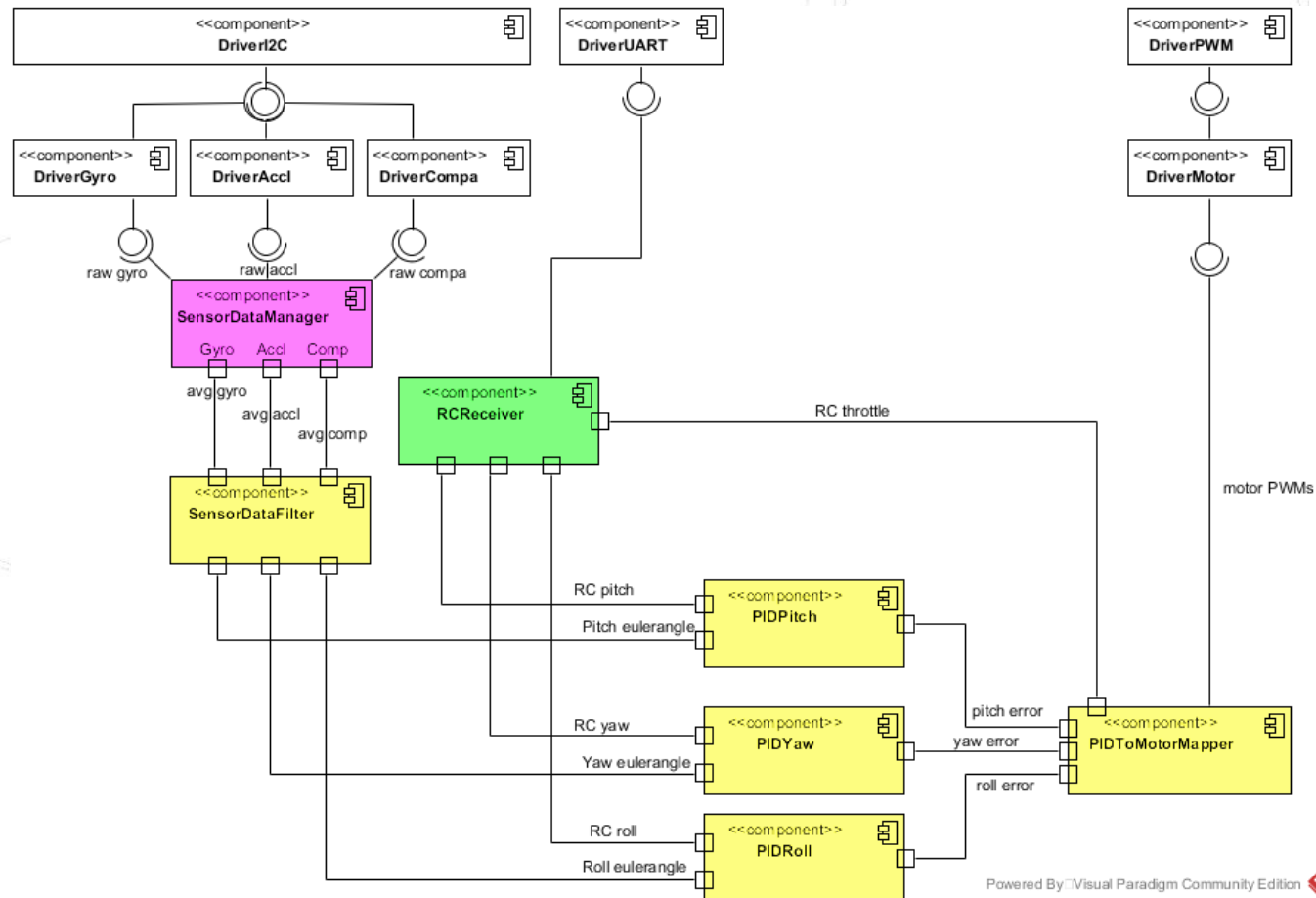
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The X-Copter Project: Flight Controller

System Architecture





The X-Copter Project: Flight Controller

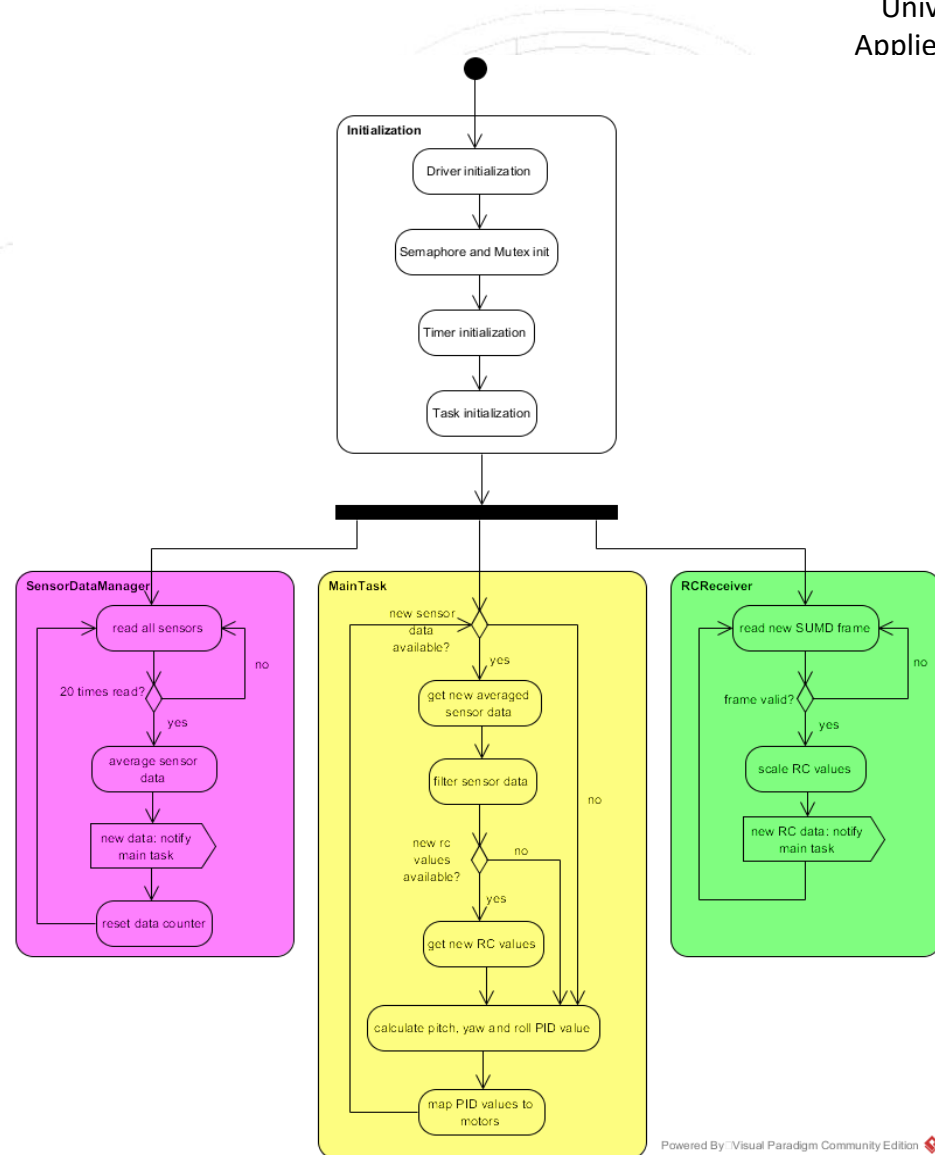
System Program Flow

1. Init state

- Driver, Mutex, Timer & Task initialization

2. Split into three tasks

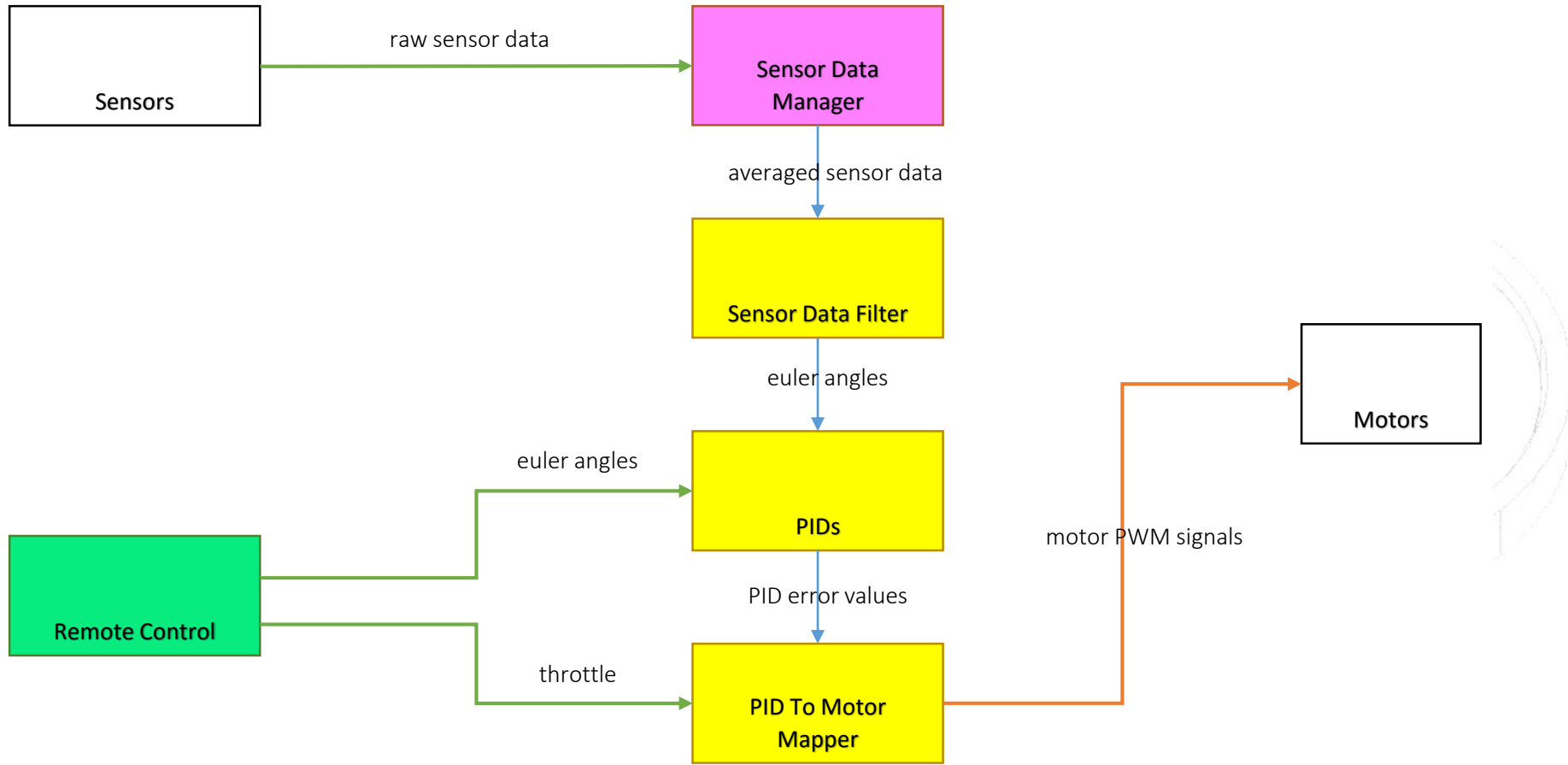
- Sensor Data Manager Task
- RC Receiver Task
- Main Task





The X-Copter Project: Flight Controller

Dataflow

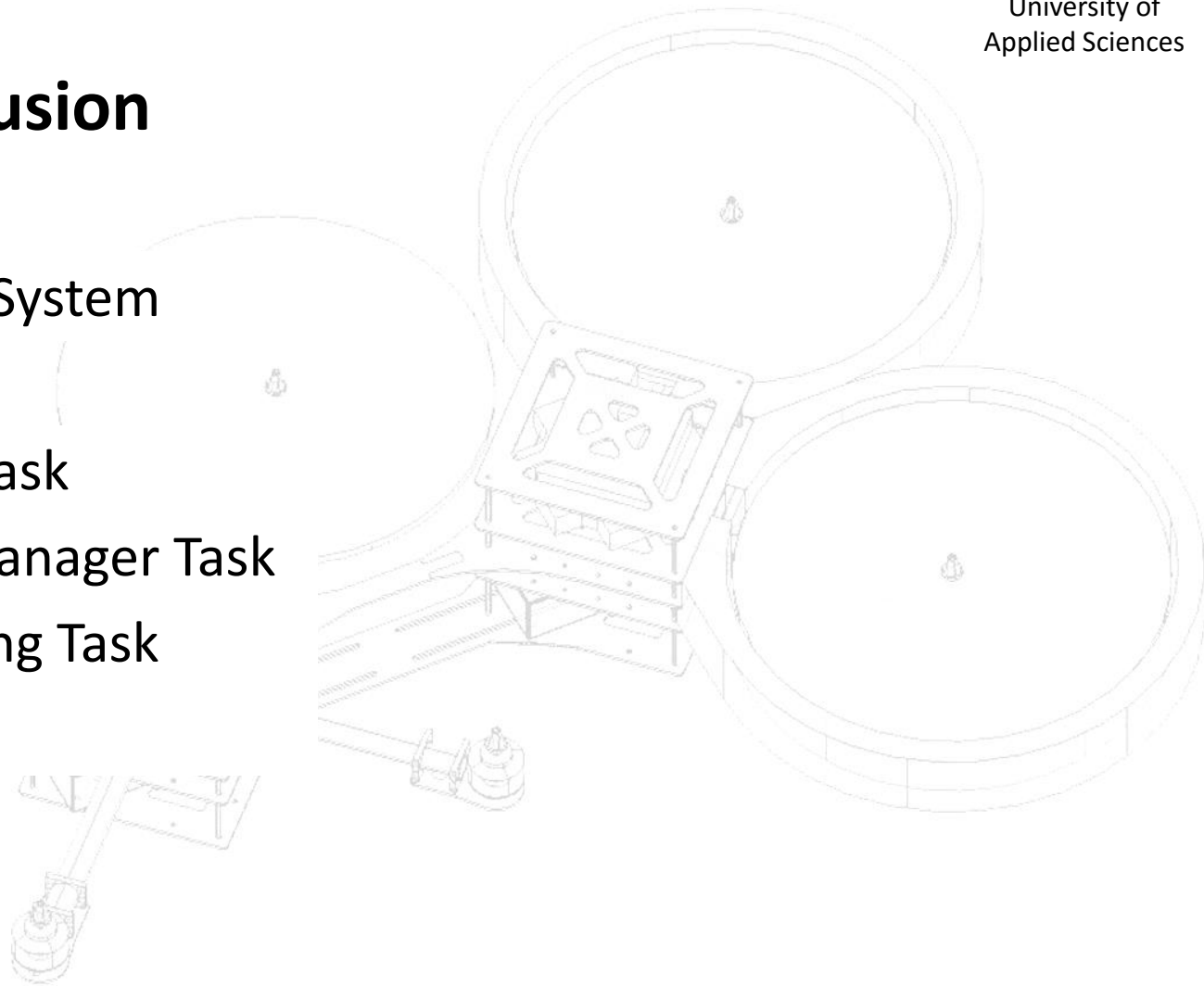




Dataflow conclusion

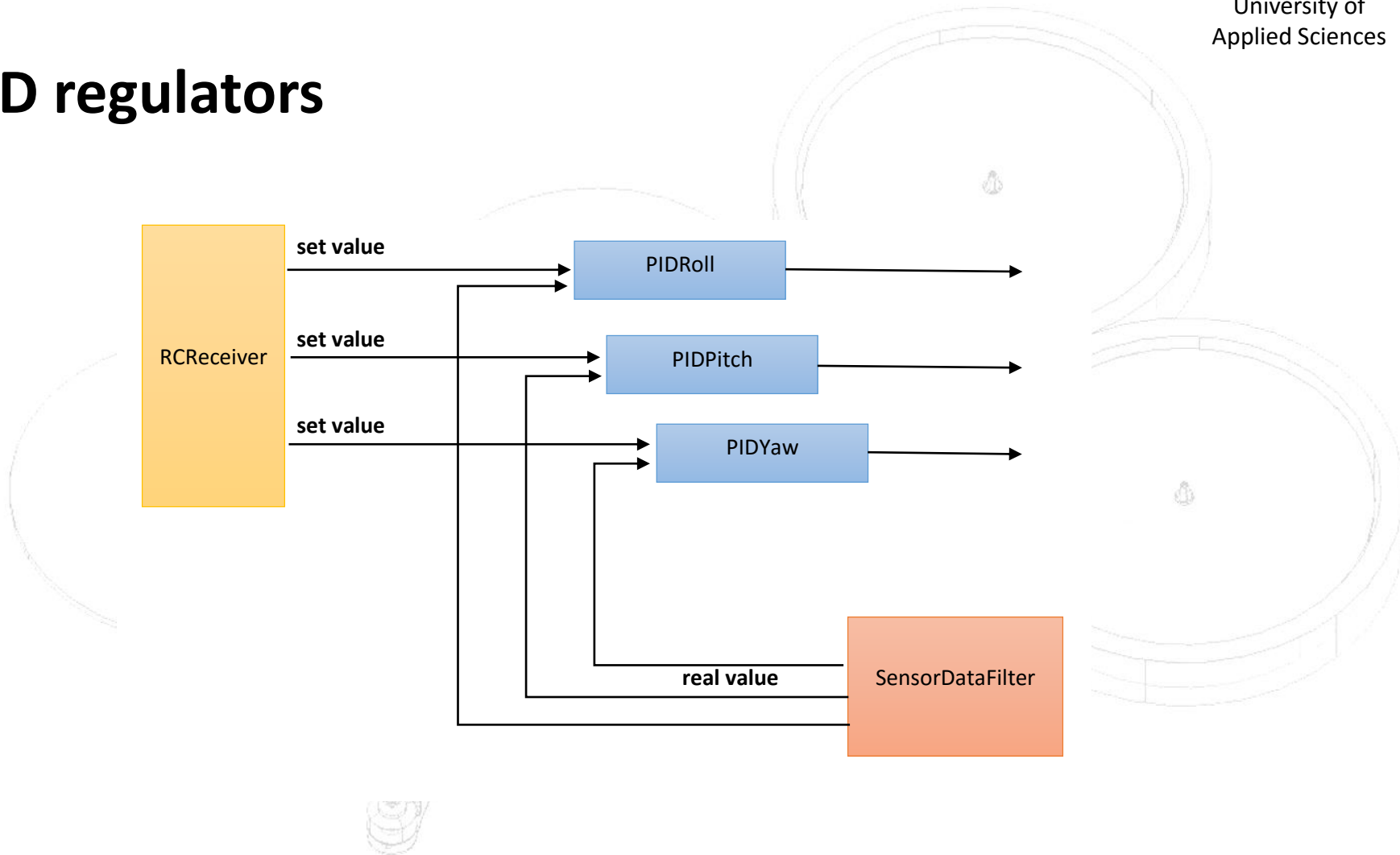
Four Tasks in the System

- RC controller Task
- Sensor Data Manager Task
- Main Controlling Task
- Logger Task





PID regulators





PIDToMotorMapper

First step:

```
//Mapping table for a QUADX configuration  
motorQuadx[0] = PIDMIX(-1,+1,-1, throttle,roll, pitch, yaw); //REAR_R  
motorQuadx[1] = PIDMIX(-1,-1,+1, throttle,roll, pitch, yaw); //FRONT_R  
motorQuadx[2] = PIDMIX(+1,+1,+1, throttle,roll, pitch, yaw); //REAR_L  
motorQuadx[3] = PIDMIX(+1,-1,-1, throttle,roll, pitch, yaw); //FRONT_L
```

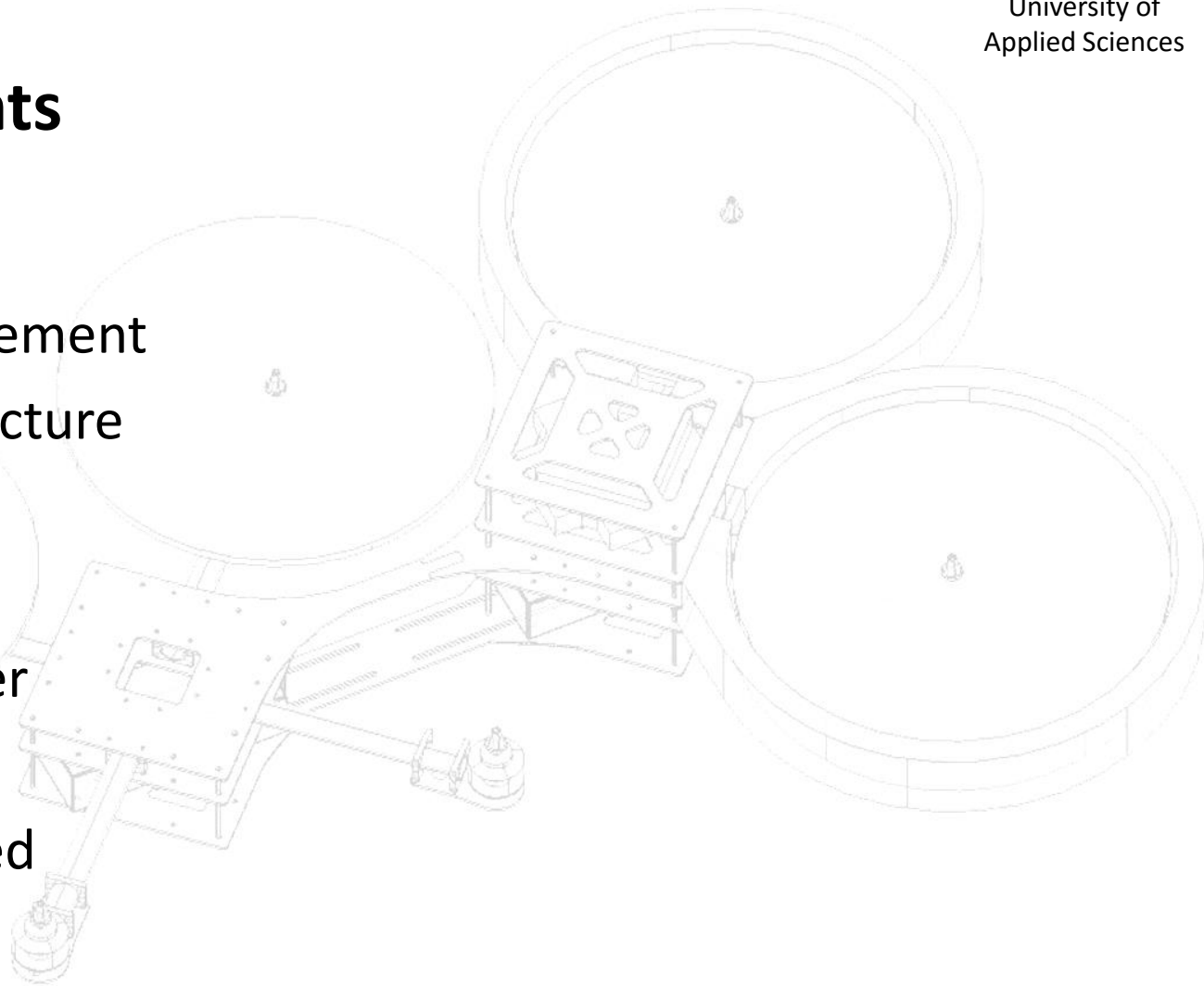
Second step:

$$C_{th} * throttle + C_{mix} * PID_{mix} = 100\%$$



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Flight controller

At this point in time the output values of the motor mapper module aren't correct!

Possible errors:

- Wrong input ranges because of a wrong conversion
- Logical error in the module itself

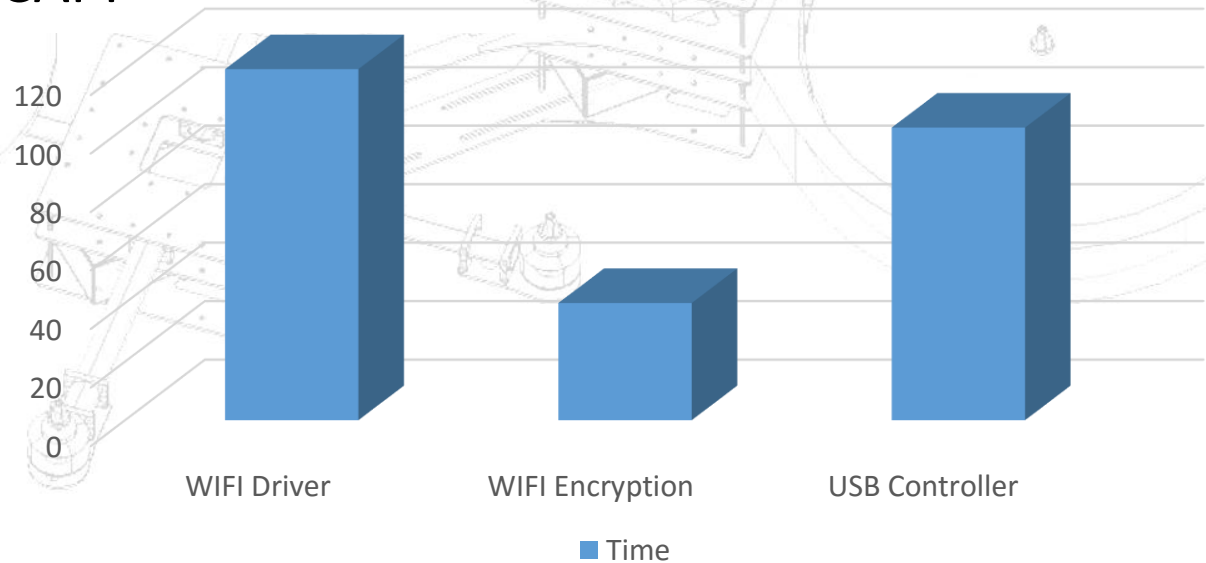




The X-Copter Project: Challenges

Linux

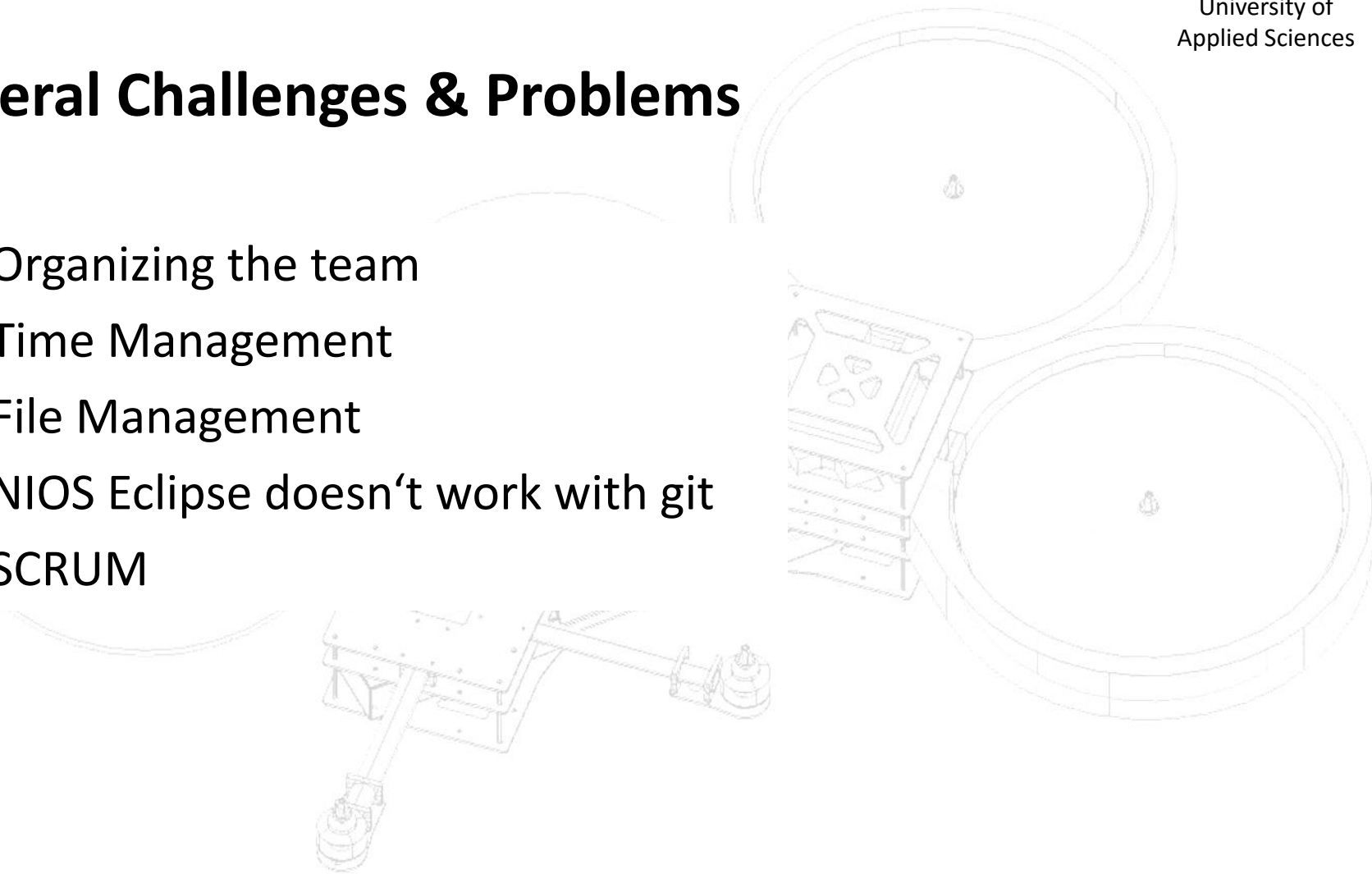
- Underestimated the complexity
- Implementation of WIFI
- USB Controller
- MAVLINK & MCAP





General Challenges & Problems

- Organizing the team
- Time Management
- File Management
- NIOS Eclipse doesn't work with git
- SCRUM





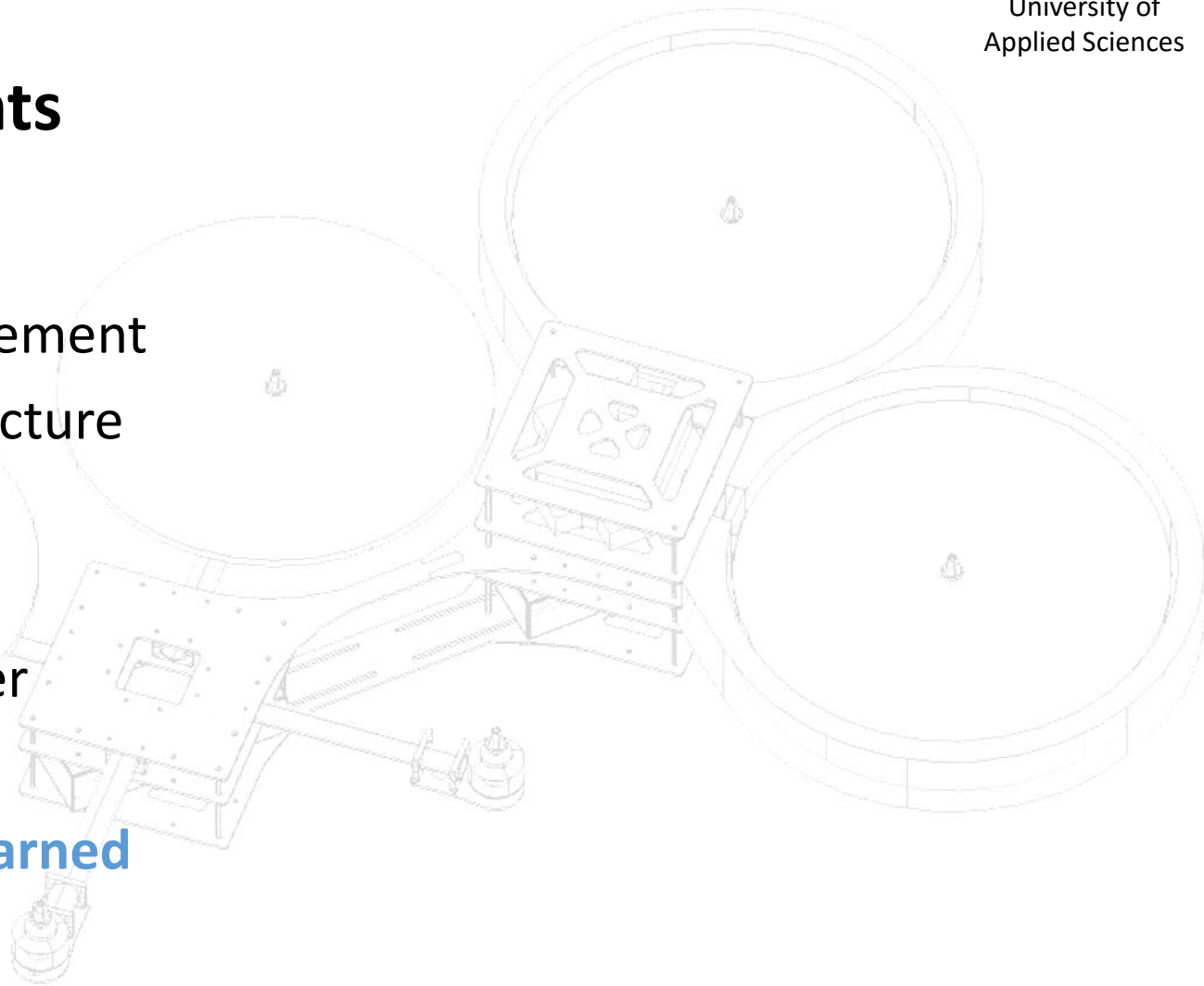
Improvements

Initial state	Actual state
Wrong USB Hardware	No USB Controller
Power supply doesn't work	Power supply works
No test flight	XCopter flies
-	In principle connection to ground station established
-	Working concept with our own flight controller



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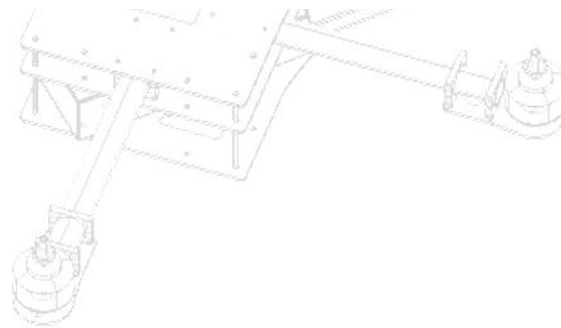
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Lesson Learned

- Do not postpone things with unknown risk
- Teamwork
- Regularly team meeting
- Generous time calculations
- Scrum only in fulltime job





Thank you for listening

