Lukas Oefner

Exposee

Development a platform to test several sensors or processes for a autonomic aircraft

Interim Report

X-Copter

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# Project Description

# Project members

* Jan Goller
  + Team
* Thomas Weber
  + Team
* Alexander Ott
  + Team
* Florian Schneider
  + Team
* Daniel Maurus
  + Team
* Stefan Gabor
  + Team
* Jochen Hoeft
  + Team
* Lukas Öfner
  + Scrum Master
  + Communicate between customer and Teams
* Benni
  + Team nie da

# Functional and non-function Requirements

# Analysis of customer needs

# System architecture

# Project documentation

## Project Management (Scrum)

## 

Scrum is an iterative and incremental agile software development methodology for managing product development. We had a lecture of Project Management by Dr. Balsen. He owns a small developing company. He used Scrum for years. Dr. Balsen show us all the positive and negative aspects of Scrum and teach us how to handle Scrum. A key principle of scrum is its agile switch of customer changes during a project. And an other main reason for Scrum is the step by step developing.

There are several roles in Scrum:

### Product Owner

The product owner is the voice of the customer. He writes customer-centric items typical, the user stories, rank them and prioritizes them. In your project the product owner is same with the customer.

### Development Team

The development team is self-organizing in Scrum. A team is made up of 3-9 persons. The team is responsible for the progress of the project. Each team had their own tasks.

In each task the actual work is described by the product owner and scrum master. If the development team finish some task the continuing with the next open task.

### Scrum Master

The scrum master coaching the team with the scrum principles. He is responsible to remove impediments of the development team. The scrum master facilitation team events like the daily scrum or other meetings. He acts as buffer between the team and the customer.

## Sprint 1

The first Sprint starts at the 13. April and ends on the 11. June. We finished a lot of tasks and reached almost our goals completely. You can see it in the Burndown Chart a picture is below. The last part where the curve doesn’t fit to the nominal value was the issue with the USB-Controller. The Problems are documented in the Impediment Backlog. All Sprint tasks are documented exact below.

1. Select the remote:

* costumer pitch about the remote
* comprasion of remotes
* price inquiry
* order the remote

1. Stable battery

* get the [circuit](http://www.dict.cc/englisch-deutsch/circuit.html) [diagram](http://www.dict.cc/englisch-deutsch/diagram.html)
* check the existing board
* build the circuit on a prototyp board

1. [Charge](http://www.dict.cc/englisch-deutsch/charge.html) [the](http://www.dict.cc/englisch-deutsch/the.html) [battery](http://www.dict.cc/englisch-deutsch/battery.html)

* programming the charger
* extern power supply

1. USB-Controller

* comprasion of USB-Controller
* proof requirements
* find a new USB-Controller

1. Commercial flight controller

* get the Software and install it
* feature list
* configure the [cruise](http://www.dict.cc/englisch-deutsch/cruise.html) [control](http://www.dict.cc/englisch-deutsch/control.html)
* connect the crusie controll to the rotors
* connect the crusie controll to the flight controller
* connect the flight controller to the X-Copter
* get a connection to the remote
* configurate the flight controller
* configurate the remote

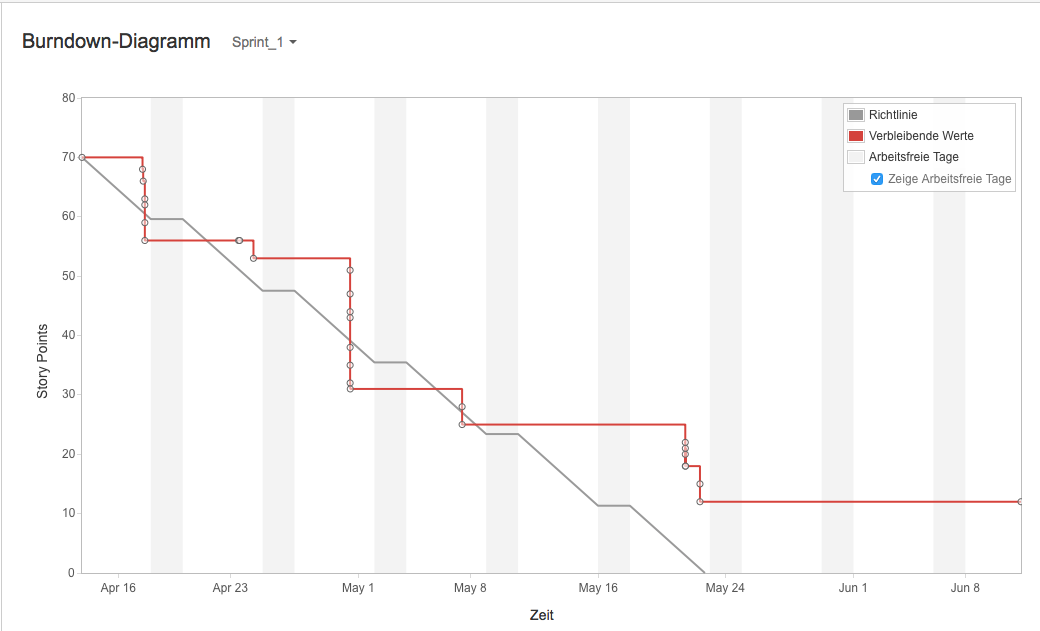


Abbildung 1 Sprint Burndown Chart

## Choice of the RC – Controller and the receiver

### The requirements for the RC- Controller and the receiver are:

* Both have to use the sum signal
* Both have to provide 4 channels minimum, better up to 6 – 8 channels
* The costs have to be less than 350€ for both of them
* The RC- Controller have to be configurable easily

### A selection of companies, they produce RC- Controller:

1. Graupner
2. Futaba
3. Spektrum
4. Modelcraft

We decided to work with a Graupner RC- Controller!

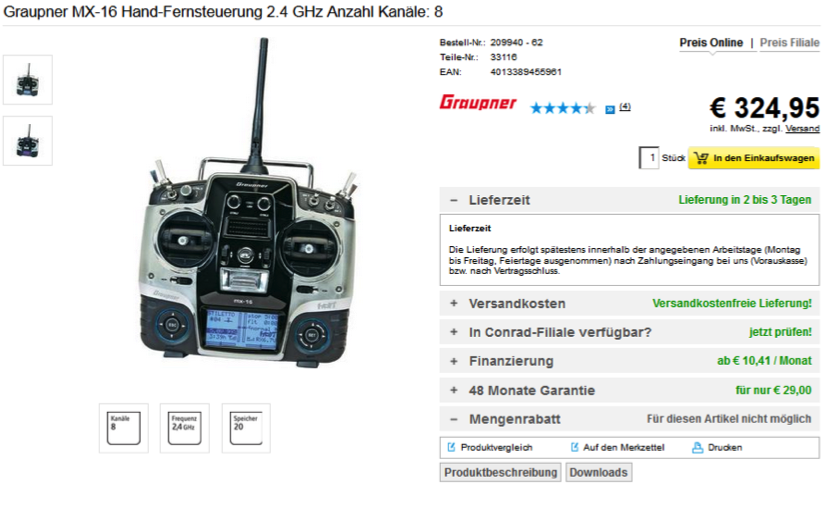
Reasons for Graupner:

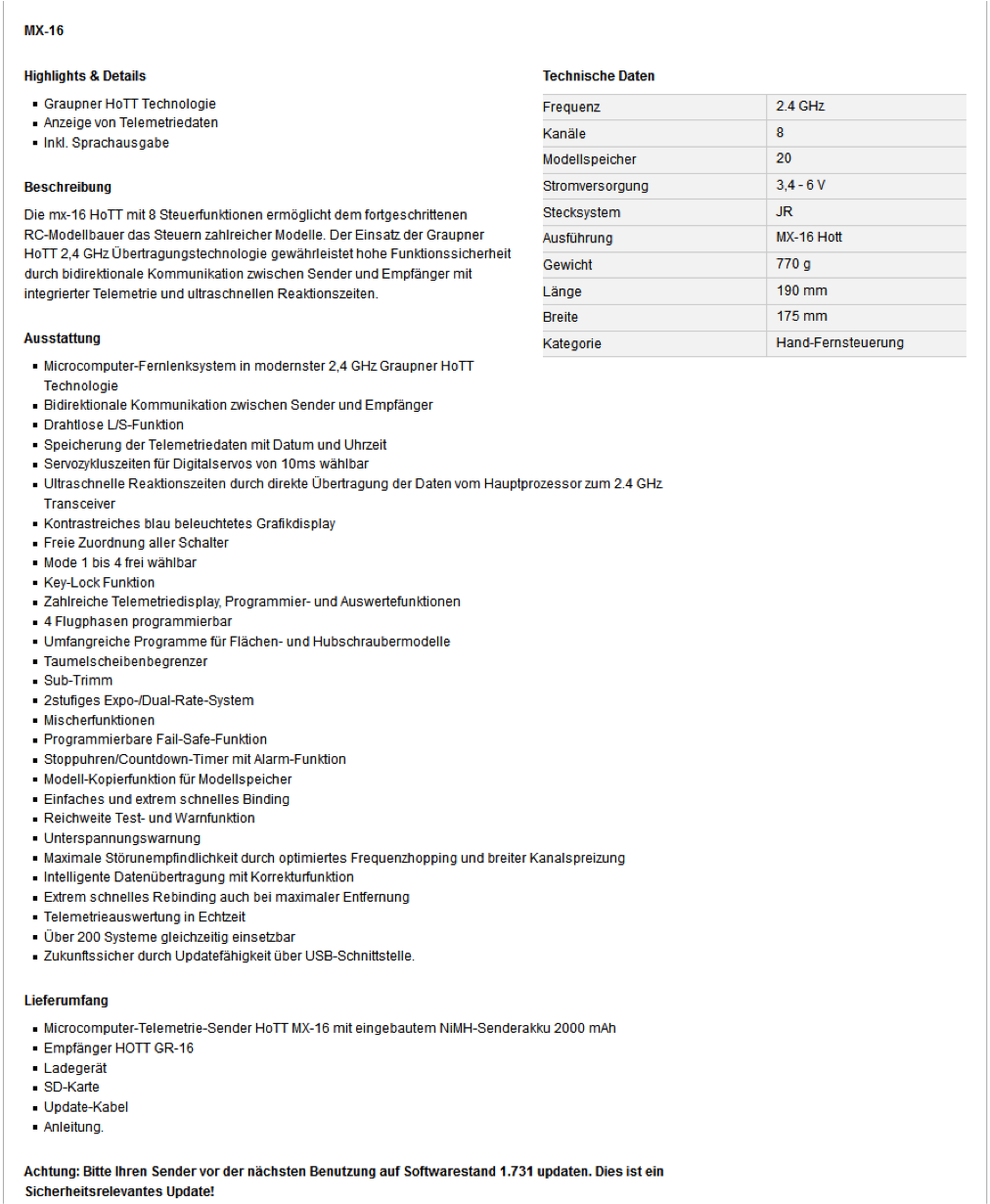
* Graupner is an innovative and leading company in RC- modelling
* Graupner ensures a high quality standart
* Graupner provides lots of datasheets for each product
* Graupner has a big RC- community

Out of the range of Graupner products we selected the “ Graupner MX 16 “:

### Major properties of the RC- Controller:

* 8 channel
* HoTT technology (sum signal, transmit up to 16 channels)
* Bidirectional communication between transmitter and receiver
* Free configurable switches
* Signal range 4 km
* Very fast rebinding





## Power supply

### Get the circuit plan

To get the circuit plan we asked Mr. Strahnen if he could provide the files and data from the BumbleBee-Project (from the last Semester), what he then did of course.

These files contained an EAGLE ® formatted plan of the circuit.

### Check the board

We knew that the power supply circuit was generated by a web app by Texas Instruments ® called WEBENCH® System Power Architect. At first we created an account to use the tool and generated a new circuit plan with the following input parameters:

* V\_in\_max : 25 V
* V\_in\_min : 13 V
* V\_out : 12 V
* I\_out : 5 A

These parameters are given by the maximum and minimum output of the accumulators (V\_in) we use and the SoC-Board restrictions which are 12V input voltage and 3.5A output current. We added another 1.5A for provision.

After that, we compared our new plan with the plan, the last project used. We figured out that they are the same so there cannot be the problem.

The next step was to compare all the components and the voltage control IC. There we saw that the last group, which designed and populated two circuit boards, used different ICs on each of them. So at least one of the boards cannot work. They also told us that when they tried to figure out the error, they probably destroyed some parts.

Big error sources are the SMD parts. The problem with them is that we cannot easily test them. There for we bought all the parts in DIP norm and built the circuit on a plugboard. The voltage control IC wasn’t available in DIP norm so we mounted it on an adapter to use it on the plug board.

## Kinect and USB Host Controller Documentation

### Initial Situation

The customer wants two Kinects to be put on the X-Copter. They are to provide 3D-Image data to map the surrounding locale of the X-Copter. To be able to communicate with two Kinects, two USB Host Controllers are needed. This is because one Kinect needs at least ~21 MB/s data transfer rate for 3D-Images at 640×480 pixels with 30 frames per second, which is too much for one controller to handle. 21 MB/s are divided into ~12MB/s for depth camera and 9 MB/s for color camera [1]. For proper 3D-Image data color- and depth camera have to work at the same time and can not be separated, which strikes out the option to save bandwidth with using only one camera at the time.

Kinect cameras will be connected via USB 2.0 plug to the USB-Controllers. For the Controllers to be able to communicate with the DE1-SOC system, an interface has to be implemented into the existing SOPC for communication between the devices. Real time 3D-Data processing will be the task of another external system with an Intel processor. Our customer stated that on a similar side project of him even an Intel I7 quad core processor is struggling with processing the data. For further information about hardware requirements of Kinect-Systems refer to [2].

### Requirements for the USB-Controller

There are certain cut in stone requirements for the USB-Controller to work with Kinect and to fit in the design of our system:

- Must be available on the market

- Must not exceed the quantity of pins our system is able to offer

- Drivers for Linux have to be available

- Chip has to have outgoing pins to be solderable

- Full High-Speed data transfer rate of 480 MBit/s

- (Should be ULPI compatible if present Waveshare 3300-Transceivers are meant to be used)

### Common USB-Controller Packages

There are three different common USB-Controller Packages that are solderable with the equipment available: QFN (Quad Flat No-leads package), LQFP (Low Profile Quad Flat Package) and TQFP (Thin Quad Flat Package). Information, advantages and disadvantages of these packages can be reviewed at [5]. QFN is harder to solder which is why QFP style packages are the preferred choice.

### Controllers that come into question

Investigation about USB-Controllers lead to a list of four different controllers that will be evaluated further in this document. The first controller is one chosen from Frank Seifert for his Bachelor's Thesis: “Conception and realization of a control computer platform for a quadcopter flying model”[6]. He compared three different solutions for USB-Controller implementation into his system. His selection included the ISP1362BD, its successor the ISP1761BE and a softcore FPGA solution. Implementing the USB-Controller directly into the FPGA fell out of the question because of the high price for an USB-Controller IP-Core (prices circle around 5000€). Open Source IP Cores for USB Host Controllers are few, have a low set of features and are badly documented, which makes them less than optimal for this project. Frank Seifert also crossed out the ISP1761BE because of a higher pin count and no Linux drivers available at the time of writing his Bachelor's Thesis. His research led him to the believe that the ISP1362BD would be best suited for his endeavors.

Further research from our side showed that Linux Drivers are available for the ISP1761BE nowadays, which would make it a suitable choice for the project. Further investigation showed that the successor to the ISP1761BE, the SAF1761BE from NXP Semiconductors, is also available to purchase and supported with Linux drivers. The fourth and last USB Controller mentioned here is the FT313H(L/P) from Future Technology Devices International Ltd.

Cypress is a another company that is also offering a wide array of USB solutions, sadly they don't have USB 2.0 Host Controllers in their repertoire.

Illustration 1: Cypress USB offerings (http://www.cypress.com/fckImages/myresources/USBControllers\_Overviewimg(1).jpg)

Chips with packages that are not solderable with the equipment at our disposal will not go into the equation.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **ISP1362BD** | **ISP1761BE** | **SAF1761BE** [3] | **FT313H(L/P)** [4] |
| **Date of production** | Rev. 04  12.2004 | Rev. 01  01.2005 | Rev.02  06.2012 | Ver.1.2  2013 |
| **Package** | LQFP64 | LQFP128 | LQFP128 | 64 LQFP  64 TQFP |
| **Driver for Linux** | yes | yes | yes | yes |
| **Transfer rate** | 96 Mbit/s | 480 Mbit/s | 480 Mbit/s | 480 Mbit/s |
| **RAM Memory** | unkn. | unkn. | unkn. | 48 KB |
| **ULPI compatible** | unkn. | unkn. | unkn. | unkn. |
| **Quantity of I/O Pins** | 27 Pins | 16Bit: 41 Pins  32Bit: 57 Pins | 16Bit: 41Pins  32Bit: 57 Pins | ? |
| **Info** | Discontinued | Discontinued | Available | Available |
| **Pros** | + Frank Seifert implemented this chip in his bachelor project | + speed  + similar to ISP1362BD | + speed  + similar to ISP1761BE | + speed  + 64 PIN package  + UMFT313EV Development Module available |
| **Cons** | - speed (too low for Kinect)  - not available | - not available | - used mainly in automotive systems  - no evaluation board | Unkn. As of time of writing |

### Conclusion

The ISP1362BD is not suitable as an USB Controller for the use with Microsoft Kinects because of a transfer rate of only 96 Mbit/s which is Full Speed USB 2.0. Kinects need at least High Speed USB 2.0 with 480 Mbit/s. Furthermore the controller is not supported anymore and it is almost impossible to obtain those controllers on today's market.

The ISP1761BE does not make the cut either. Although it supports High Speed USB 2.0 and has Linux drivers, it has a larger footprint with its LQFP128 package and is also discontinued. Its successor the SAF1761 which is similar in features is mainly used in automotive systems which means that it is not available in the common consumer market.

Which leads us to the FT313H(L/P) which offers the best characteristics for our endeavors. It is still supported, offers Linux drivers. It has a relatively low footprint, is solderable with the tools at hand and comes in two packages: 64LQFP and64TQFP. It supports High Speed USB 2.0 transfer rates and can also be ordered with a development module.

## Charging Batteries for the X-Copter

**Info:** This little tutorial describes how to charge our batteries for the X-Copter-Project

|  |  |  |
| --- | --- | --- |
|  | **Identifier:** | **Information:** |
| **Hardware:** | **Battery1 (LiPo\_01)** | **Name:** FlightPower Hacker evo 20 4900mAh 6S1P  **Charging:** continuous: 20C, burst: 50C, charging: 1C  **Stored in:** Speicher[31] as LiPo\_01 |
| **Battery2 (LiPo\_02)** | **Name:** XTRON 40C 5000mAh 6S1P  **Charging:** continuous: 40C, burst: 80C, charging: 4C  **Stored in:** Speicher[20] as LiPo\_02 |
| **Battery3 (NiCd\_01)** | **Charging:** loading current: 110mAh  **Stored in:** Speicher[19] as NiCa\_01 |
| **Charging-Station:** | Ultra Duo Plus 60 |

We saved three configurations in the Ultra Duo for our batteries named: Lipo\_01, Lipo\_02 and NiCd\_01

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Battery Overview** | | **LiPo\_01** | **LiPo\_02** | **NiCd\_01** |
| Cell-Count: | | 6 | 6 | 4 |
| **Nominal** | Cell-Voltage | 3.7V | 3.7V |  |
| Total-Voltage | 22.2V | 22.2V |  |
| **Max.** | Cell-Voltage | **4.2**V | **4.2**V |  |
| Total-Voltage | **25**V | **25**V |  |
| **Min.** | Cell-Voltage | 3V | 3V |  |
| Total-Voltage | 18V | 18V |  |
| **Max. Charge Current** | | 4.9 A (1C) | 20 A(4C) |  |

**Hint: The maximum charge power is not above 80 W.**

**Important:** Warnings and security information are found in the documentantion-pdf:

6478\_ULTRA DUO PLUS 60\_de.pdf

You should read that before using the charging station as the information therein will not be in this tutorial.

### Charging Batteries:

**Current charged per charging session** = current \* charging time

Refer to the datasheet of your batteries for information about max. current for charging.

**Standard-charging-current** is 1/10 of the capacity (1.7Ah capacity -> 170mA standard-charging-current)

1. Plug power cable to start charging device
2. Connect charging cables to charging station (red = plus, black = minus)
3. Recommend for LiPo’s: Connect cell adapter to “Balance” board and “Balance” board to charging station
4. We will use the CC/CV charging-mode for our batteries as fast-charging not supported by every type

## Commercial Flight control

In order to test the construction of the XCopter for the first time,

without wasting too much time on developing an own flight control.

We decided to install a commercial flight control. In this case the DJI NAZA V2 was used.

It is a fully developed flight control unit, which was developed to be easily installed in any multi copter system. It comes with an integrated 3-axis gyro sensor and acceleration sensor as well as an external GPS unit. The only items which need to be connected to it are all Electronic speed controllers (ESCs) and a RC-receiver, the gimbal(DJI camera) part is not necessary.

If every Electronic Part is connected properly, the flight controller has to be configured by following these steps:

1. Download the driver and the Assistant installation software in EXE format from www.dji.com.
2. Switch on the transmitter and then power on your autopilot system.
3. Connect your autopilot system and PC via a Micro-USB cable (according to image 1).

Required connections for USB:

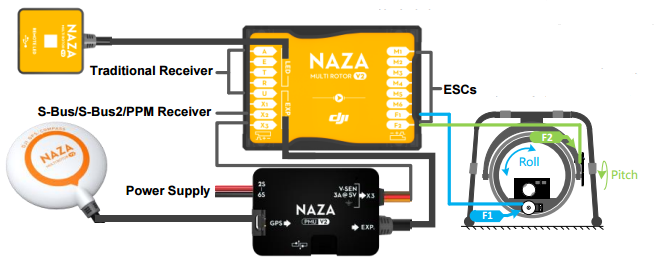
* NAZA V2 Power Management Unit at **Exp.**
* V-Sen wire from PMU at **X3**
* USB adapter at **LED**

1. Open the driver installation software and follow the instructions to complete installation.

Important: The NAZA V2 has to be connected to install this driver

1. Run the Assistant installation software and follow the instructions to complete installation.
2. Select the “Basic” option. Please follow step-by-step for your first-time-configuration. Basic configuration is necessary, including Mixer Type, Mounting, RC, and Gain settings.

Further information can be found in the Help text of the NAZA V2 Assistant Software.



Screenshot from the DJI NAZA V2 quick start guide.

Evaluation by the team

# Lessons Learned

Abbildung 1 Sprint Burndown Chart 11

# Literaturverzeichnis

**Im aktuellen Dokument sind keine Quellen vorhanden.**