



DHL Parcelcopter research flight campaign 2014 for emergency delivery of medication

***Dieter Moormann, RWTH Aachen University
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The Task

Emergency delivery of medicine to the island of Juist

Currently medicine is delivered to the island twice a day from Pharmaceutical wholesale finally transported

- by aircraft from Norddeich airport to Juist airport and from there
- by horse drawn carriage to the pharmacy:

- no Medicine delivered after 6pm
- no Medicine delivered on foggy days

DHL selected 2014 scenario:

Emergency delivery of medicine **if no alternate transport mean is available:** if no ferry (low water) or aircraft (fog, night, after 6pm) can go

Facts about the island of Juist



- Island North of Germany, 1.800 inhabitants, 100.000 tourists p.a.
- Island „without cars“; goods and people are transported via horse-drawn carriages (buckboards)
- Distance Norddeich - Juist: 12 km
- Ferry: 1-2 per day. (90min), departure time depending on tide
- Flights: 6-10 per day, flight time: about 5 min

The Challenge

Emergency delivery of medicine to the island of Juist if no alternate transport mean is available:

Research Partners / Consortium:

- **DHL** (originator and leader of project, scenario definition, integration into logistics chain)
- **Microdrones** (parcelcopter 2.0)
- **RWTH Aachen University** (optimizing performance, robustness, permit to fly for flight beyond visual line of sight BVLOS, flight test and flight operation)

together with the German authorities:

- led by Lower Saxony's Ministry for Economics, Labor and Transport
- German Ministry of Transport and Digital Infrastructure (MoT), Bonn, Germany
- ATM: DFS Deutsche Flugsicherung GmbH, Langen, Germany
- National Park Wadden Sea (tideland, mudflat), Wilhelmshafen, Germany

set up a research project to

- **to supply the pharmacy of Juist with urgently needed medicine**
- **from 6pm to 8pm on a regular basis, serving real needs**
- **using the fully automatically flying DHL parcelcopter**

German legal framework

RPAS-Permits to fly

§ 16 I no. 7 LuftVO

- VLOS,
- ≤ 100 meters AGL,
- ≤ 25 kg,

general permit

- ≤ 5 kg
- no combust engine
- not above specific danger spots, restricted aereas

single permit

- all other operations

- with **no danger** to public safety and order
- **data protection** legislation

Exceptional permission

§ 15a III sentence 3 LuftVO

exception

- all other operations not mentioned in § 16 I no. 7 LuftVO

But following these conditions:

- in restricted areas or within the airspace of an landing site
- no danger to public safety and order
- with an air traffic control approval (if applicable)
- dutiful discretion of the relevant administration

German legal framework

The permit authority is not the Federal Aviation Administration (Luftfahrt-Bundesamt (LBA))

but the Aviation Authorities of the 16 states.

Parcelcopter 2014-project in Juist:

Permit Authority is Lower Saxony's (Niedersachsen) Ministry of Transport

since June 2012

The Federal Ministry of Transport (MoT) established the "Common Principles for granting a permit to fly" for a similar policy.



Federal Ministry of Transport and Digital Infrastructure

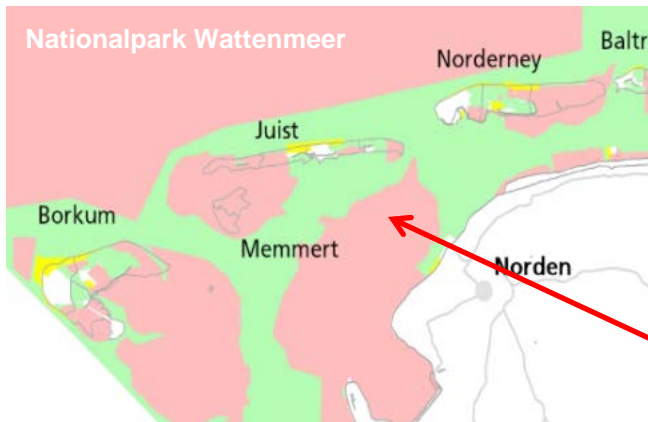


Challenge: Permit to Fly for BVLOS Operation in a National Park

Parcelcopter 2014-project:

Lower Saxony's Ministry of Transport granted the Permit to Fly („Aufstiegsgenehmigung“) containing all limitations and restrictions

After consulting „Deutsche Flugsicherung“ (DFS) the German Ministry of Transport (MoT) defined a Restricted Area („Flugbeschränkungsgebiet“) . DFS activated it via NOTAM for each day of campaign day on request.



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(E3107/14 NOTAMN
Q)EDWW/QRRCA/IV/BO/W/000/003/5339N00705E005
A)EDWW B)1410291100 C)1410312100
D)29 1100-2100, 30 AND 31 0800-2100
E)ACTUAL UTILISATION OF ED-R JUIST, REF AIP SUP VFR 12.
F)GND G)300FT AMSL)
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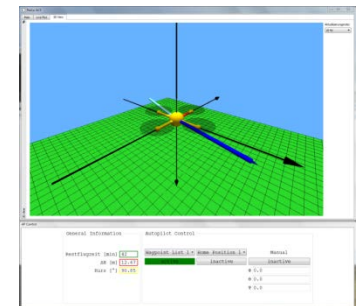
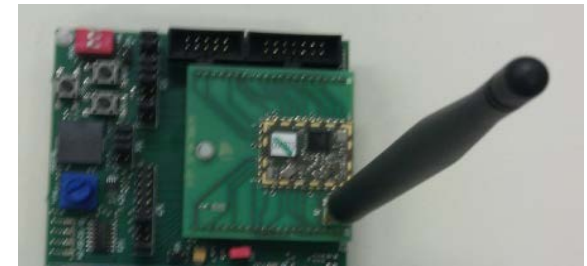
An additional Permit was issued by the National Park Authorities of „Lower Saxony Wadden Sea“ to ensure wildlife protection

Technical Challenges DHL Parcelcopter 2014

based on the safe and highly reliable Microdrones Md4-1000 the **DHL Parcelcopter** was **adapted and optimized** to be operated **BVLOS** in the **harsh North Sea weather conditions**:

- Copter: Adding DHL transport container
- Copter: Improving navigation accuracy for precise automatic take-off and landing
- Copter: Improving Control algorithms for enhanced performance (range) and enhanced robustness (wind / gust / turbulence)
- Copter: Introducing safety concept and emergency landing into Autopilot
- DataLink: Integrating Longe Range modules (range > 15km)
- RPS: Adding means for Monitoring and Control for BVLOS operation

Perform extensive flight test program prior first flights at North Sea in Aachen (RWTH Aachen University) and Siegen (Microdrones)



DHL Parcelcopter 2.0 Data

The DHL Parcelcopter is a quadrocopter system

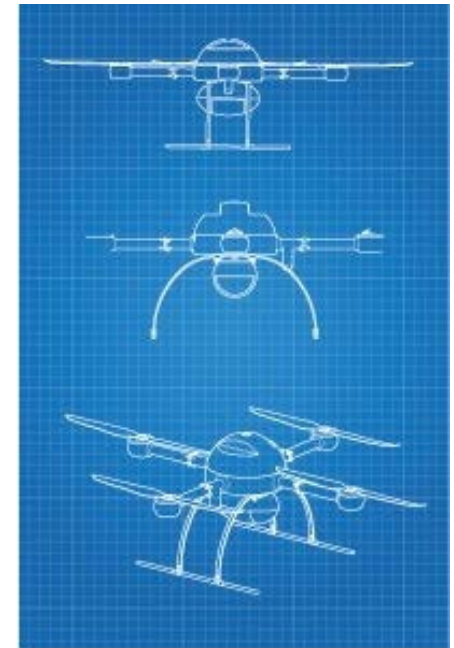
- overall total weight up to 6 kg including max payload of 1.2 kg
- endurance up to 45 min, range of data link up to 15 km
- electrically powered
- very low noise level (< 44db in 50m distance)

is safe and reliable

- continuously monitored by BLOS remote pilot station
- dedicated emergency moding
- carbon fibre transport box ensure save transport

is highly automated and robust

- fully automatic flight including take-off and landing
- Innovative sensor system ensuring precise navigation
- robust design and control system ensures operation in the harsh weather conditions at the North Sea (wind, turbulence, night, rain, snow, fog, ...)



BLOS - Remote Pilot Station (RPS)

Monitoring & Control of the Parcelcopter
(including Emergency Handling):

- Position, Height and Velocity
- Attitude
- System Parameters,
Health Status

Mobile Remote Pilot station consists of

- Two sets of remote pilot stations
(redundant)
- Fail-Op Power Supply
- Data Link Antennas, Interfaces
(Long Range, WiFi, LTE/UMTS)
- Weather Station
- Communication to Air Traffic Control



RPAS Monitoring & Control via Long Range Data Link

Long Range System:

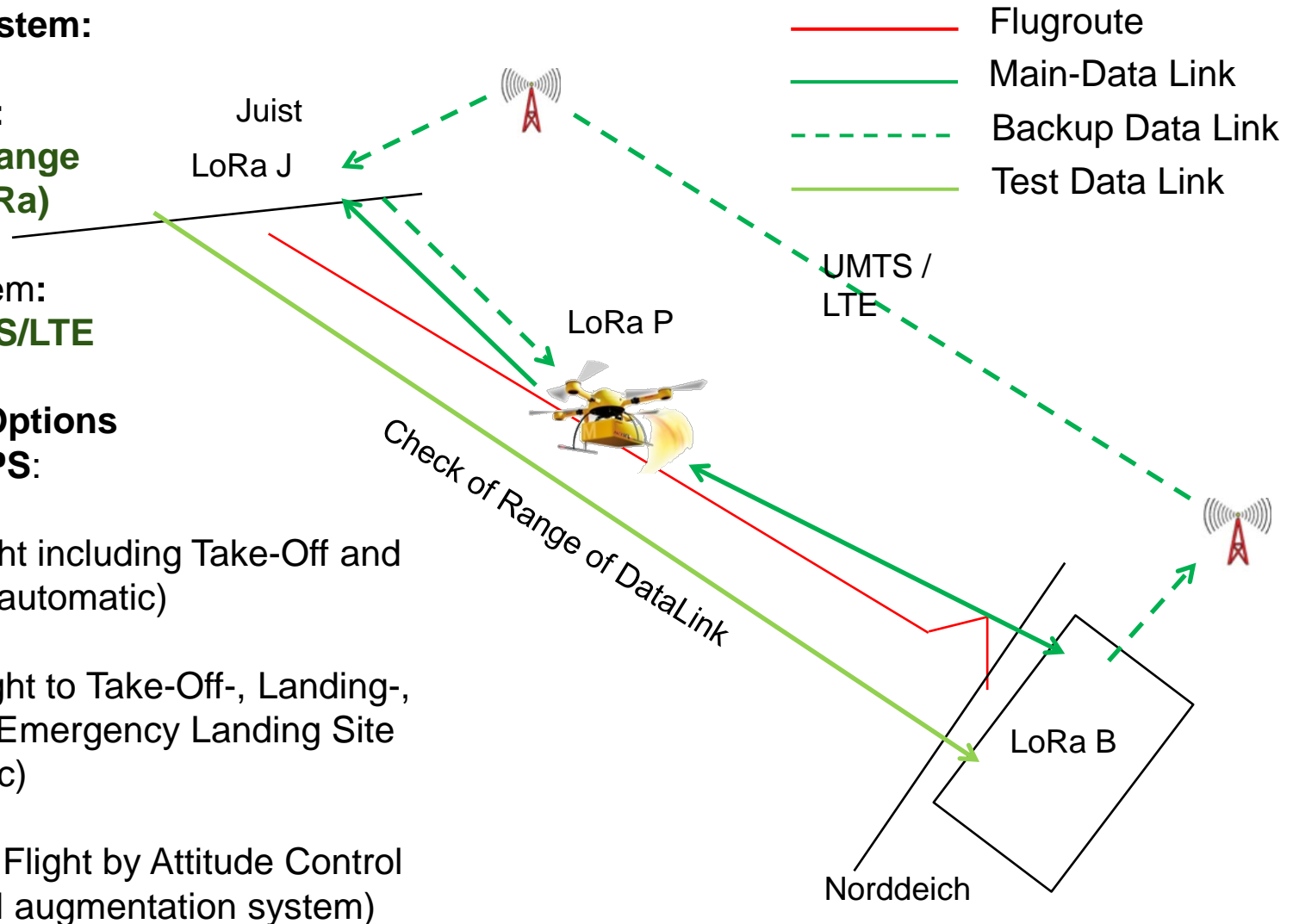
- Main System:
**IMST LongRange
868 Mhz (LoRa)**
- Backup System:
LoRa + UMTS/LTE

Three Control Options available via RPS:

AUT: AutoFlight including Take-Off and Landing (fully automatic)

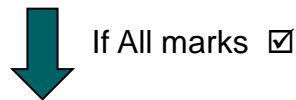
DIR: Direct flight to Take-Off-, Landing-, or predefined Emergency Landing Site (fully automatic)

MAN: Manual Flight by Attitude Control (control augmentation system)



Preflight Procedure (Abstract)

- Check Parcelcopter (e.g. GPS) and container
- ...
- Check weather and weather forecast (Norddeich/Juist)
- Range Check DataLink
- ...
- Check Current weather at all locations
- AutoCheck all systems



If All marks

Inform ATC and Tower of Juist Airport

Check Readiness Safety Pilot and Safety Zone

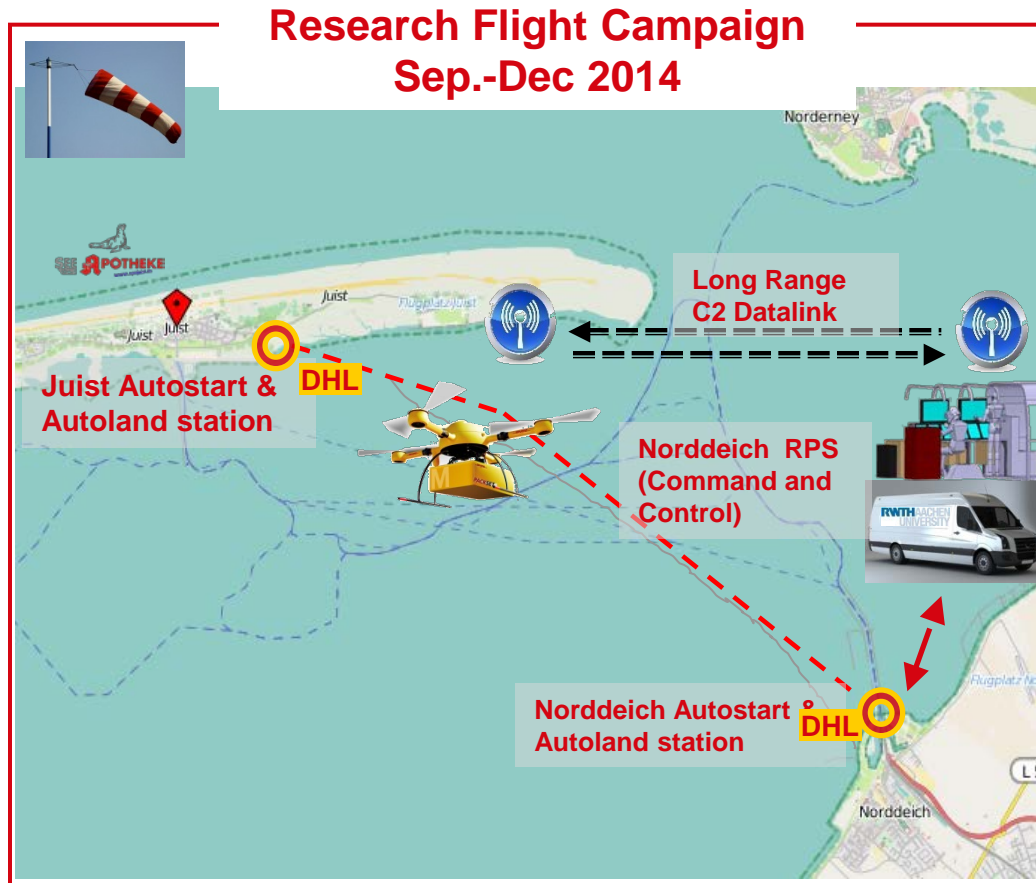
Cleared for Take-Off



No flight



Summary (Video): DHL Parcelcopter research flight campaign 2014 for emergency delivery of medication



... DHL Parcelcopter research flight campaign successfully performed without incidents !

https://www.youtube.com/watch?feature=player_embedded&v=AlxsVkk-B-c

https://www.youtube.com/watch?feature=player_embedded&v=KoJIKNeNGn0

Thank you for your attention !

Prof. Dr.-Ing. Dieter Moormann
Institute of Flight System Dynamics,
RWTH Aachen University
52072 Aachen, Germany
moormann@fsd.rwth-aachen.de
www.fsd.rwth-aachen.de
Phone: +49 241 80 96810

for further information on the DHL parcelcopter project see e.g.:

http://www.dhl.com/en/press/releases/releases_2014/group/dhl_parcelcopter_launches_initial_operations_for_research_purposes.html

Additional support with respect to contacts and expertise by the UAV-DACH association, consisting of 80 „German language“ RPAS producers, researchers and end users. UAV DACH is member of UVS International

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www.uavdach.org



Summary (1/2): DHL Parcelcopter research flight campaign 2014 for emergency delivery of medication

In 2014, DHL Parcel has launched a unique pilot project between the North Sea island of Juist and the mainland: For the first time worldwide, urgently needed goods were delivered by a Remotely Piloted Aircraft, the DHL Parcelcopter, to the island at certain times of the day on a regular and scheduled basis.

The DHL Parcelcopter, a special copter build by Microdrones GmbH, was used for emergency care for island residents and tourists by transporting medicine across the sea over a distance of about 12km. Depending on the weather conditions, the Parcelcopter was able to carry up to 1.2 kg of medicine, which was delivered to Juist in 15 to 25 minutes. The uniqueness of this research project resides in the fact that the operation of a Remotely Piloted Aircraft System (RPAS) took place beyond visual line of sight of the Remote Pilot (RP) in a real-life mission in combination within the challenging weather conditions at the North Sea.



To ensure safe operation outside of sight of the RP (beyond visual line of sight – BVLOS) in the real world, several challenges had to be solved. RWTH Aachen University supported DHL in an extensive consultation and approval process led by Lower Saxony's Ministry for Economics, Labor and Transport. In coordination with DFS Deutsche Flugsicherung GmbH, the German Ministry of Transport and Digital Infrastructure established a restricted flight area

Summary (2/2): DHL Parcelcopter research flight campaign 2014 for emergency delivery of medication

exclusively for this research project. In addition to the island of Juist and the city of Norden, the Wattenmeer National Park administrative unit approved the Parcelcopter flights.

Technical challenges to be solved due to BVLOS requirements were solved by high levels of automation during all phases of flight from automatic take-off to automatic landing. For safety reasons, and in compliance with the requirements set by the responsible authorities, the Parcelcopter was constantly monitored during its flight by a mobile Remote Pilot Station (RPS) located on the mainland. This allowed manual action to be immediately taken by the RP, if a malfunction or emergency occurred. The RP also maintained constant contact with air traffic controllers to ensure proper reaction (if e.g. a rescue helicopter would cross the route of the Parcelcopter). Special emphasis of RWTH Aachen research activities was put on the robustness of the system with respect to the typically high levels of gust and turbulence over the North Sea. Range and flight time were optimized to maximize the availability of the Parcelcopter system to ensure delivery at times when alternatives for transportation of medicine, such as ferries and manned flights, are not available.

During the 3 month research flight campaign various delivery flights were performed without incidents. Flights were performed during day and night time and also in fog. It could be demonstrated that the DHL Parcelcopter is safe and reliable and suitable for the considered emergency care. As part of the ongoing research activities it is evaluated, whether such delivery methods to thinly populated or remote areas or in emergencies are technically feasible and economically sensible
