IT in general aviation:
Pen and Paper vs. Bits and Bytes

Master thesis

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Author:

Dipl.-Jur. Sebastian Höhne

Theaterstraße 14 C | 30159 Hannover | Germany

sebastian@hoehne.ag | http://www.hoehne.net

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Matriculation number (University of Oslo):	552198

Abstract

The use of IT in general aviation is an issue not being widely discussed. The intersection of IT and law with a flavor towards aviation is quite rare, although the use of IT (both „*Pen and Paper*" as well as „*Bits and Bytes*" based solutions) is ubiquitous and gains more and more importance in everyday routines.

And as long the IT works as expected that is not to be qualified as a problem. However, the law has the task to foresee difficulties and try to find the right balance between freedom and security.

Embedded in the aforementioned context, the thesis starts with analyzing the fundamental facts, shifts towards the legal framework applying to general aviation and provides an overview of important institutions for the EU and culminates in the in-depth inspection of the actions and measures are concerning pilots in general aviation every day.

Dedication

Thomas Höhne, Marita Höhne & Sarah Berkelmann
for their magnificent support during the endeavor of the LL.M. studies

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Glossary & list of abbreviations

ADS-B .... Automatic Dependent Surveillance Broadcast

AIS .... aeronautical information services

AMC .... Acceptable Means of Compliance

ANS .... Air Navigation Service

ANSP .... Air Navigation Service Provider

AS .... Autonomous Systems

ATC .... Air Traffic Control

ATM .... Air Traffic Management

BGP .... Border Gateway Protocol

BT-Drucks. .... Bundestagsdrucksache

CO$_2$ .... carbon dioxide

CA .... Certificate Authorities

CAT .... Commercial Air Transport Operations

CCC .... Chaos Computer Club

CD-ROM .... Compact Disk - Read Only Memory

CMS .... Content Management System

CRL .... Certificate Revocation List

CVFR .... Controlled Visual Flight Rules

DFS .... Deutsche Flugsicherung

DIY .... Do It Yourself

DVD .... Digital Versatile Disk

DWD .... Deutscher Wetterdienst

e.g. .... exempli gratia

EASA .... European Aviation Security Agency

EC .... European Commission

ECJ .... European Court of Justice

EFB .... Electronic Flight Bag[s]

et seq. .... et sequentes

ETA .... Estimated Time of Arrival

NOTAM	notice(s) to airmen
NZA	Neue Zeitschrift für Arbeitsrecht
OCSP	Online Certificate Status Protocol
p.	page
PaaS	Platform as a Service
PGP	Pretty Good Privacy
PIC	Pilot In Command
PIN	Personal Identification Number
PKI	Public Key Infrastructure
pp.	pages
PRNG	Pseudo Random Number Generator
QES	Qualified Electronic Signature[s]
RA	Resolution Advisory
RAM	Random Access Memory
RFC	Request For Comments
SaaS	Software as a Service
SERA	Standardized European Rules of Air
SES	Single European Sky
SESAR	Single European Sky Air Traffic Management Research Programme
SPO	Special Operations
SSL	Secure Sockets Layer
t	tonne
TAF	Terminal Aerodrome Forecast
TCAS	Traffic Alert and Collision Avoidance System
TCP	Transmission Control Protocol
TLS	Transport Layer Security
TTP	Trusted Third Party
UAV	Unmanned Aerial Vehicle
USA	United States of America
USB	Universal Serial Bus
USD	United States Dollar
v.i.	vide infra
v.s.	vide supra
VFR	Visual Flight Rules
VMC	Visual Meteorological Conditions

A. Introduction

I. Presentation of the topic

> „*The Wright Brothers created the single greatest cultural force since the invention of writing. The airplane became the first World Wide Web, bringing people, languages, ideas, and values together.*"[1]

Aviation with heavier-than-air-crafts[2] is a relatively new development of the human skill set. The idea of flying anywhere was only a dream over centuries.[3] Given that the first proven flight of an airplane was performed in the year 1903 (it can be argued whether this happened on the 18th of August by Karl Jatho in Hannover, Germany[4] or on the 17th of December by Wilbur and Orville Wright in Kitty Hawk, USA[5]), this very early milestone was reached just 110 years[6] ago. Only eleven years later Tony Jannus performed a flight in what is called the first scheduled airline on the 1st of January 1914.[7]

Since then, the air traffic has grown dramatically: Air traffic management[8] in Europe handles 2600 daily flights and it is very likely that this number will double by 2020.[9] In 2013 the 240 airlines represented by the International Air Transport Association[10] are expected to achieve a revenue of $711 billion[11] and make $12.7 billion profit, resulting in a 1.8% profit margin.[12] Having this very low profit

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[1] Alleged citation of BILL GATES. Although this quote is used often (e.g. VASIGH/ TALEGHANI/JENKINS [2012], *Aircraft Finance*, p. 95; ANDERSSON [2005], *The New Airline Code*, p. 320; STROHMEIER [2012], *Inauguration Speech*, p. 16 (p. 16); HAZEN/LYNCH [2008], *The role of transportation in the supply chain*, p. 85 or ENGLISH [2003], *The Air Up There*, p. 110), the exact origin or date could not be established.

[2] For an overview of the discovery of a hot air balloon by Joseph-Michel & Jaques-Etienne Montgolfier in 1780 and the following development it may be referred to BARTSCH [2012], *International Aviation Law*, pp. 1 et seq.

[3] DATOR [2012], *Social Foundations of Human Space Exploration*, p. 19.

[4] HIRSCHEL/PREM/MADELUNG [2004], *Aeronautical Research in Germany*, p. 30; persuasive affirmative: HARTUNG [2009], *Tüftler und Querdenker* and SPIES [2010], *Der Irrtum der Luftfahrthistoriker*.

[5] ANDERSON [1997], *A History of Aerodynamics*, p. 242.

[6] Or 112 years if one chooses to believe in the alleged flight of an airplane performed by Gustav Weißkopf on the 14th of August 1901 in Bridgeport, USA: KLUSSMANN/MALIK [2004], *Lexikon der Luftfahrt*, p. 319.

[7] MCCARTHY [2003], *Aviation in Florida*, p. 159.

[8] Hereinafter abbreviated as »ATM«.

[9] EUROCONTROL [2011], *Single European Sky*, <http://www.eurocontrol. int/dossiers/single-european-sky>.

[10] Hereinafter abbreviated as »IATA«.

[11] Unless stated otherwise $ means USD.

[12] INTERNATIONAL AIR TRANSPORT ASSOCIATION [2013], *Strong Passenger Growth Trend Continues*, <http://www.iata.org/pressroom/pr/Pages/ 2013-07-03-01.aspx>.

margin in mind, it has to be stated that for the aviation industry changes in technology can very easily lead to a driving force „*in the competitive arena or in the industry itself that creates some kind of momentum or pressure for change in the industry itself*".[13] One example of such a driving force could be the replacement of paper with electronic devices. American Airlines is deploying electronic flight bags[14] (in this case specially configured 1.35 pound Apple iPads) in its fleet, which replaces 35 pounds of paper-based reference material and manuals per plane - this change in technology is assumed to save the company a minimum of $12 million in fuel (400.000 gallons) annually.[15] JetBlue is also deploying EFB in its fleet and through their upcoming Ka-band satellite capability in the aircrafts, the devices will even have real-time capability to update weather information, flight or safety documentation.[16]

In general aviation the figures are smaller, but the underlying problems are the same: To what extent is taking a risk[17] worth the benefit[18]? Although „*paper documents are not immune to alteration or manipulation*"[19], the robustness of this analogue medium is quite high: archival-grade acid-free paper achieves a lifespan of 100 to 250+ years[20], newspaper 10 to 50 years[21]. In unfair comparison, an iPad has an a non-disposable „*[b]uilt-in 42.5-watt-hour rechargeable lithium-polymer battery*" giving the device energy for „*[u]p to 10 hours of surfing the web on Wi-Fi, watching video, or listening to music*".[22] Determining wether „*Pen and Paper*" or „*Bits and Bytes*" based solutions are legally preferable (or in fact prohibited) will be the common thread of this thesis.

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[13] GLOURIS/OSWALD [2006], *Designing and Executing Strategy in Aviation Management*, p. 65.

[14] Hereinafter abbreviated as »EFB«.

[15] AMERICAN AIRLINES [2013], *American Airlines Completes Electronic Flight Bag Implementation*, <http://hub.aa.com/en/nr/pressrelease/american-air lines-completes-electronic-flight-bag-implementation>; short video demonstration: Idem [2013], *American Airlines now using Apple's iPad in all cockpits*, <http://www.youtube.com/watch?v=AGmeavqhObw>.

[16] JETBLUE [2013], *JetBlue Gives Pilots New iPad Capabilities*, <http://investor.jetblue.com/phoenix.zhtml?c=131045&p=irol-newsArticl e&ID=1833045>.

[17] Like the use of a digital device which might fail.

[18] E.g. lesser fuel consumption due to weight reduction, better usability or simplified access to documents.

[19] ALGHAMDI [2011], *The Law of E-Commerce*, p. 30.

[20] *Klingler* in: BATES [2012], *Understanding Information Retrieval Systems*, p. 255.

[21] *Klingler* in: idem [2012], *Understanding Information Retrieval Systems*, p. 255.

[22] APPLE [2013], *iPad - View all the technical specifications*, <http://www.apple.com/ipad/specs/>.

II. Methodology

This thesis focusses on the legal aspects of IT in general aviation within the territory of the EU. Since the thesis is written for a „*legal informatics study programme*" and an „*information and communication technology law master*" this work is inter alia recognizing hard facts which are outside of a strictly legal display. The premises of reality shall not be ignored.

Laws concerning aviation are laws that always have to have the safety of the measures laid down in mind. Technical aspects are forming the underlying premise for achieving safety - therefore, the fundamentals will contain technical aspects of IT in necessary detail. Due to the word limit the explanations are quite brief and explanatory examples are seeded rarely. An interested reader is well advised to follow up on the given comprehensive literature to gain a deeper insight and better understanding. Since there is no need to reinvent the wheel when displaying and summarizing mere (technical) facts, the fundamentals[23] will be quite descriptive.

Various examples of the study will be centered around the pilot in command, analyzing how potential actions or measures of the pilot are legally classified. To meet that task, this thesis shall be divided into sections covering the legal framework and important institutions,[24] the briefing process[25], the actual flight[26] and the debriefing act[27].

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[23] V.i. B., *Fundamentals*, p. 4.
[24] V.i. C., *Legal framework and important institutions*, p. 28.
[25] V.i. D., *Briefing*, p. 40.
[26] V.i. E., *Flying*, p. 52.
[27] V.i. F., *Debriefing*, p. 57.

B. Fundamentals

I. General aviation

Aviation is a wide field and contains a lot of sub genres. The first split may be done by dividing military aviation and civil aviation from each other.[28] However, when it comes to general aviation, which at first might sound like a smaller sub genre of civil aviation amongst many others, it has to be stated that „*[g]eneral aviation is the largest segment of aviation based on number of aircraft, number of pilots, and number of airports and communities served*"[29].

1. General aviation flight operations

The probably most used definition of general aviation is „*[a]ll civil aviation operations other than scheduled air services and non-scheduled air transport operations for remuneration or hire*"[30]. This definition reveals the most important key factor in general aviation: Although it might be counter-intuitive, general aviation only describes the circumstances of the operations carried out.

„*Scheduled services are commercial services open to the public and operating to a published schedule (timetable)*"[31]; this type of aviation is transporting most of the passengers[32] and could be further distinguished between scheduled airlines, charter airlines, low cost airlines, & air taxi services[33]. Air cargo is recognized by most governments as a part of passenger services, because most scheduled passenger services also carry cargo freight and only very few airline

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[28] For a clear outline regarding the differences between civil and military aviation it may be referred to ABEYRATNE [2012], *Air Navigation Law*, p. 6.

[29] WENSVEEN [2011], *Air Transportation*, p. 126.

[30] E.g. FEDERAL AVIATION ADMINISTRATION [2012], *Aeronautical Information Manual*, p. PCG-G1; TRANSPORT CANADA [2012], *Glossary: G*, <http://www.tc.gc.ca/eng/civilaviation/opssvs/secretariat-ter minology-glossary-215.htm>; VOLPE [2008], *Aviation Security Dictionary*, p. 84; WIKIMEDIA FOUNDATION [2013], *Wikipedia: General Aviation*, <http://en.wikipedia.org/wiki/General_aviation>; SENGUT-TUVAN [2007], *Principles of Airport Economics*, p. 447; PALK [2007], *Differences in Airport Operational Efficiencies and Environmental Impact*, p. 16.
Although the ICAO Convention Annex 6 Part II can be found as a source for this definition in various publications, only the term „General aviation operation" is defined as „*An aircraft operation other than a commercial air transport operation or an aerial work operation.*" in the ICAO Convention Annex 6 Part I Chapter I p. 3 and in the ICAO Convention Annex 6 Part II Chapter 1.1 p. 5.

[31] AUST [2010], *Handbook of International Law*, p. 321.

[32] „*Commercial airlines carry between 600 and 800 million people per year and move 20-25 billion tons of cargo*"; PRICE/FORREST [2013], *Practical Aviation Security*, p. 5.

[33] ROBINSON/LÜCK/SMITH [2013], *Tourism*, pp. 87 et seq.

services are cargo-only flight operations.[34] Scheduled air services must be „*open to [...] members of the public*" and operated within a „*published timetable or with flights so regular or frequent that they constitute a recognizable systematic service*".[35] Since, by definition, general aviation is seen as the absence of „*a scheduled air service*" or „*air transport for remuneration or hire*", every passenger flight that is „*not open to use by members of the public*" or is not carried out within a „*published timetable or with flights so regular or frequent that they constitute a recognizable systematic service*" has to be considered as general aviation.

2. General aviation aircraft types

The definition of general aviation is completely independent from the gear used and focusses only on the circumstances of the operation. Therefore, general aviation can take place with every aircraft: The full range from an Airbus A380[36] down to a Auto Gyro MTOSport[37] or even a human-powered helicopter[38] may be used for general aviation operations. If an Airbus A380 would be used for an individual flight over 5000 km, the emissions would be 460 times higher than the same flight in a scheduled commercial aircraft flight (economy class) per capita.[39] Matters concerning all unmanned aerial vehicles[40] will

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[34] ABEYRATNE [2012], *Aeronomics and Law*, p. 51.

[35] ICAO Doc. 7278-C/841 of the 10th of May 1952; the full definition reads:
„*A scheduled international air service is a series of flights that possesses all the following characteristics:*
a) it passes through the airspace over the territory of more than one State;
b) it is performed by aircraft for the transport of passengers, mail or cargo for remuneration, in such manner that each flight is open to use by members of the public;
c) it is operated, so as to serve traffic between the same two or more points, either:
i) according to a published timetable, or
ii) with flights so regular or frequent that they constitute a recognizably systematic series."

[36] The biggest passenger plane: ROBINSON/LÜCK/SMITH [2013], *Tourism*, p. 90; KEMP [2007], *Flight Of The Titans - Airbus A380 vs. Boeing 787*, pp. 161 et seq.

[37] An autogyro with an MTOW of 450 kg: AUTO GYRO [2010], *Feel the difference: The new MTOsport.*

[38] On the 13th of June 2013 the aeronautical startup Aerovolo flew with their human-powered helicopter "Atlas" 64 seconds, gaining a maximum altitude of 3.4 meters; WISE [2013], *Finally! A Human-Powered Helicopter Wins the $250,000 Sikorsky Prize*, <http://www.popularmechanics.com/technology/aviation/diy-flying/finally-a-human-powered-helicopter-wins-the-250000-sikorsky-prize-15682369>.

[39] The energy use for air travel over 5000 km would emit 0.555 t CO_2 in a commercial aircraft (economy class), 2.125 t CO_2 in a private jet and 253.761 t CO_2 in an Airbus A380: SCOTT/HALL/GÖSSLING [2012], *Tourism and Climate Change*, p. 107.

[40] Hereinafter abbreviated as »UAV«.

be excluded from the scope of this thesis. The UAVs in use for military purposes operate outside civil aviation[41]. Civil-driven UAVs may be used for conducting general aviation flight operations,[42] and since projects like „*Balloon & Kite Mapping*"[43] are getting more and more attention[44] there will be questions arising as how to regulate the use of airspace with light UAVs. However, the European Aviation Safety Agency[45] is interested in, but not regulating, UAVs under 150kg because the certification and control remains within the power of the national authorities.[46]

3. General aviation airports and airfields

Airports and airfields have unique codes for clear identification. For general aviation a four-letter code[47] which is issued[48] by the International Civil Aviation Organization[49] is used, for scheduled air services this is a three-letter code[50] issued by the IATA[51]. While small airfields accommodate only general aviation, large airports are mostly used for scheduled passenger flights and cargo. The passengers choice of an airport is linked to various factors.[52] The capacity of an airport[53] is one of them. The passenger and baggage flow[54] within the passenger terminal[55] is crucial to scheduled air services[56]. In general aviation, the number of passengers is much smaller and the schedules of the planes used for general aviation are not that

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[41] V.s. B I., *General aviation*, p. 4.

[42] V.s. B I 1., *General aviation flight operations*, p. 4.

[43] A DIY kit is available from as low as $100; PUBLIC LAB [2013], *Balloon and Kite Mapping*, <http://publiclab.org/wiki/balloon-mapping>.

[44] E.g. LIPPINCOTT [2012], *Balloon & Kite Mapping Workshop*, <http://lanyrd.com/2013/osbridge/schmqz/>, SCHWAN [2013], *Open-Source-Mapping mit Ballons*, <http://heise.de/-1930094>.

[45] Hereinafter abbreviated as »EASA«.

[46] DALAMAGKIDIS/VALAVANIS/PIEGL [2012], *On Integrating Unmanned Aircraft Systems into the National Airspace System*, p. 76.

[47] The Airport in Hannover would be translated to „*EDDV*"; the airport for Oslo (Gardermoen) to „*ENGM*".

[48] INTERNATIONAL CIVIL AVIATION ORGANIZATION [2013], *Location Indicators (Doc 7910)*.

[49] Hereinafter abbreviated as »ICAO«.

[50] Airport Hannover: „*HAJ*"; Airport Oslo (Gardermoen): „*OSL*".

[51] The Airline Coding Directory of the IATA in a printed version was discontinued in 2012, nowadays only a digital version is getting distributed: INTERNATIONAL AIR TRANSPORT ASSOCIATION [2013], *Airline Coding Directory (ACD)*, <http://www.iata.org/publications/Pages/coding.aspx>.

[52] For an overview see HALPERN/GRAHAM [2013], *Airport Marketing*, pp. 48 et seq.

[53] ASHFORD/MUMAYIZ/WRIGHT [2011], *Airport Engineering*, pp. 234 et seq.

[54] Idem [2011], *Airport Engineering*, pp. 417 et seq.

[55] Idem [2011], *Airport Engineering*, pp. 414 et seq.

[56] BAZARGAN [2010], *Airline Operations and Scheduling*, p. 183.

tight. Therefore, airports have own General Aviation Terminals[57] for general aviation flight operations.[58] The dispatch through a GAT is much more convenient, personal and faster compared to the regular terminals.[59] Nevertheless, airports with a high frequency of departures and arrivals, resulting in capacity shortages, can try to avoid general aviation traffic by raising the landing and service fees accordingly.[60]

4. General aviation safety level

The following operation classification scheme is used by the EASA to „*develop a different set of technical rules*" for the concerning different operations, „*taking into account the principle of proportionality*" and the „*need for different safety levels*"[61]:

Figure 2: EASA Classification Scheme

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[57] Hereinafter abbreviated as »**GAT**«.

[58] The Airport Hannover (HAJ/EDDV) GAT is located at the GPS coordinates +52° 27' 45.27'', +9° 41' 35.24''; Oslo Airport (OSL/ENGM) GAT at +60° 11'59.29'', +11° 4' 30.74''.

[59] CONRADY/FICHERT/STERZENBACH [2013], *Luftverkehr*, p. 252.

[60] Fraport (FRA/EDDF) for example has a basic charge for all aircrafts up to 15.000 kg MTOM of € 200 above and beyond other fees: FRAPORT [2013], *Airport Charges and Charges for Central Ground Handling Infrastructure*, <http://www.frankfurt-airport.com/content/frankfurt_air port/en/misc/container/entgelte/flughafenentgelte-01-2013/jcr: content.file/130525_entgelte-charges-2013-2.pdf>; general aviation traffic is therefore dodging to the airfield Frankfurt-Egelsbach (QEF/EDFE).

[61] EUROPEAN AVIATION SAFETY AGENCY [2013], *EASA initiatives in order to provide Better Regulation for General Aviation*, <http://www.easa.europa. eu/flightstandards/ga-ba.html>.

Subsequent to the negative definition of general aviation which only excludes scheduled air services and non-scheduled air transport operations for numeration or hire, general aviation can take place in all classes listed in the EASA classification scheme. Especially business aviation[62] will occur most likely as an unscheduled[63] commercial air transport operation (CAT), demanding the highest safety level.

Special operations[64] will not be analyzed in this thesis, due to the possibility of Member States to grant exceptions to SPO flights.[65] SPOs are including

„*(a) police and customs missions;*

(b) traffic surveillance and pursuit missions;

(c) environmental control missions conducted by, or on behalf of public authorities;

(d) search and rescue;

(e) medical flights;

(f) evacuations;

(g) fire fighting;

(h) exemptions required to ensure the security of flights by heads of State, Ministers and comparable State functionaries", Art. 4 № 1 Commission Implementing Regulation (EU) No. 923/2012.

The focus will be laid on commercial air transport operations[66], operations with complex aircrafts[67] and operations with non-complex aircrafts[68] including various safety levels.

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[62] For a market analysis it may be referred to LANG et al. [2012], *Business Aviation in Europa*.

[63] As not open to the public or without a published timetable.

[64] Hereinafter abbreviated as »SPO«.

[65] E.g. Art. 4 Commission Implementing Regulation (EU) No. 923/2012.

[66] Hereinafter abbreviated as »CAT«.

[67] Hereinafter abbreviated as »NCC«.

[68] Hereinafter abbreviated as »NCO«.

II. Information technology

1. Information

Although everyone seems to know information as such and is able to classify any given information as information, no one can define it precisely.[69] It is established, that information is intangible.[70] Often the transferability between a sender and a receiver is seen as a mandatory element of information.[71] This, albeit small, restriction will be followed here and a wide definition will be used.

If one tries to define information and uses the term „*data*" in the definition,[72] while data is being defined by the term „*information*",[73] a vicious circle[74] is being concluded. Some require for information to have a meaning in opposition to data; the result would be that every information contains data but data not necessarily information.[75] That premise would break the aforementioned vicious circle, however, for the purpose of this thesis, the terms information and data may be used synonymously, while data may have a slight touch regarding being processed electronically. The smallest entity of information or data is one bit.[76]

2. Technology

The term technology has no common definition.[77] Technology may for example be understood „*as the human reconfiguration of natural materials and natural scientific processes*"[78], „*as the process by which*

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[69] HOEREN [2013], *Internetrecht*, p. 11, <http://www.uni-muenster.de/Jura.itm/hoeren/materialien/Skript/Skript_Internetrecht_April_2013.pdf>.

[70] BEA/FRIEDL/SCHWEITZER [2005], *Allgemeine Betriebswirtschaftslehre*, p. 342.

[71] E.g. LOCHMANN [2008], *Information*, pp. 9 et seq.; BT-Drucks. 14/6098, p. 23; GREIF [2008], *Information und Gesellschaft*, pp. 11 et seq.; WAGNER [2000], *Binäre Information*, pp. 121 et seq.; as a premise in GARY [2009], *Annäherung Systemtheorie*, pp. 12 et seq.; MÖBIUS [2006], *Unser Weltbild*, pp. 18 et seq.; BEYER [1990], *GRUR 1990*, p. 399 (pp. 401 et seq.).

[72] E.g. MEGILL [2013], *Thinking for a Living*, p. 67; *Knox* in: COHEN [2007], *Information and Beyond*, p. 681; *Floridi* in: SOMMARUGA [2009], *Formal Theories of Information*, p. 16; GORDON [2007], *Principles of Data Management*, p. 3.

[73] E.g. DUMAS [2013], *Diving into the Bitstream*, p. 20; *Lai/Schildkamp* in: SCHILDKAMP/LAI/EARL [2013], *Data-based decision Making in Education*, p. 10; *Atkinson* in: ATKINSON et al. [2013], *The DATA Bonanza*, p. 16; ALKIN [2011], *Evaluation Essentials*, p. 88.

[74] In the meaning of MARVIN [2011], *Dictionary of Scientific Principles*, p. 465.

[75] MATTHEWS [2013], *Electronically Stored Information*, p. 303.

[76] „*[T]he resulting units may be called binary digits, or more briefly bits, a word suggested by J. W. Tukey*": SHANNON [1948], *A Mathematical Theory of Communication*, <http://cm.bell-labs.com/cm/ms/what/shannonday/shannon1948.pdf>.

[77] UECKE [2012], *How to Commercialise Research in Biotechnology?*, p. 76.

[78] CROCKER [2012], *A Managerial Philosophy of Technology*, p. 44.

humans modify nature to meet their needs and wants"[79] or as „*varieties of tools and rule systems that is collaborated for a common purpose*"[80]. The first two examples of definitions have a human-subjective premise, whereas the third example is independent from a human-driven inventive step.[81] A broader understanding will include already existent tools and rules systems.[82] Given that human invention that creates technology often copies or is based on natural processes,[83] a wide understanding of the term technology is preferable.

3. The unification of information and technology

Information technology, or in its unified occurrence IT, seems to be a quite modern appearance at first glance. In fact the task of distributing or archiving information is a very old one, for which many different technologies have been used. From cave painting in the El Castillo cave ≈40.800 years ago[84], the invention of writing on papyrus ≈5.000 years ago[85], the alleged tables of stone written with gods finger handed down to Moses[86] ≈3.300 years ago[87] to the use of paper ≈1.900 years ago[88].

Starting to use, not necessary interconnected, computers or processing information electronically in general in the 19th century is a „*tremendous human achievement*" and is sometimes referred to as the „*second industrial revolution*".[89]

Some concepts, which are a few decades old, come fresh polished under nice sounding marketing names back into the every day life.

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[79] Selwyn [2011], *Education and Technology*, p. 6.

[80] Liu et al. [2010], *Theory of Science and Technology*, p. 1 quoting Encyclopedia.

[81] An inventive step is for example required by Art. 52 EPC for a patent and defined in Art. 56 EPC.

[82] The „*technology of nature*" would be included, see von Uexküll [2010], *A Foray Into the Worlds of Animals and Humans*, pp. 193 et seq.

[83] As a catchphrase for this process „*biomimicry*" was used in the early 90s by Tran [1993], *Biosensors*, p. 1 or *Pincus* in: Riste/Sherrington [1996], *Physics of Biomaterials*, p. 1, now there are whole books dealing with „*biomimicry*" or „*biomimetics*": e.g. Harman [2013], *The Shark's Paintbrush*; Lakhtakia/Martin-Palma [2013], *Engineered Biomimicry*; Ramalingam et al. [2013], *Biomimetics*.

[84] Wang [2013], *Near-Infrared Organic Materials and Emerging Applications*, p. 1.

[85] Malone [2012], *The Guardian of All Things*, p. 56.

[86] Exodus 31:18.

[87] Given that Moses lived in ≈1.300 B.C.: Weber [2005], *Wirtschaft und Gesellschaft I/22*, p. 217.

[88] Szczepanowska [2013], *Conservation of Cultural Heritage*, p. 117.

[89] *Bynum* in: van den Hoven/Weckert [2008], *Information Technology and Moral Philosophy*, p. 19.

IT in general aviation: Pen and Paper vs. Bits and Bytes

Dipl.-Jur. Sebastian Höhne   B II 3. The unification of information and technology

One good example for such a reappearance is „*cloud-computing*".[90] The origin of this term, in its present meaning and context, dates back to the year 2006.[91] The concept of a terminal and a mainframe was state of the art when computing power was very expensive. The IBM 3270 terminal[92], introduced in 1971, had to be connected to a cluster controller, which only directed the commands to the mainframe after the user hit enter.[93]

The main difference between then and cloud computing: the physical location of the mainframe was known and under control of a certain entity; when a user utilizes some cloud service nowadays, it is completely unknown where the processing takes place.[94] The routing to the cloud service also does not necessarily disclose the location, nevertheless, the routing may give a hint about the perimeter of the location.[95] Software as a service[96], platform as a service[97] and infrastructure as a service[98] were available on or as mainframes back in the days - the terms are older than the term cloud-computing.[99] However, cloud-computing consists of SaaS, PaaS and IaaS,[100] with the flavor of the unknown server location. Some (cloudy)[101] services that are offered for general aviation will be analyzed later on.

Given the aforementioned deliberations, the term IT covers both Pen & Paper and Bits & Bytes based solutions. However, the clash

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[90] Offers concerning general aviation which might fall under the category of cloud-computing will be analyzed later on.

[91] Used by ERIC SCHMIDT on a conference on the 9th of August 2006: REGAL-ADO [2011], *Who Coined 'Cloud Computing'?*, <http://www.technologyreview.com/news/425970/who-coined-cloud-computing/>.

[92] Successor to the IBM2260 display terminal introduced in 1964.

[93] And not every keystroke on the terminal was handled by the mainframe. When there were a lot of terminals involved, this was a huge saving: STEPHENS [2008], *What on Earth is a Mainframe?*, pp. 65 et seq.

[94] KRUTZ/VINE [2010], *Cloud Security*, p. 7.

[95] Although it is a very bad idea to mess around with the border gateway protocol (BGP), the routing can be spoofed, e.g.: WILL [2013], *The Pirate Bay - North Korean hosting? No, its fake. (P2)*, <http://rdns.im/the-pirate-bay-north-korean-hosting-no-its-fake-p2> or STIENNON [2010], *Surviving Cyberwar*, pp. 68 et seq. Furthermore, networks are not divided by countries or geographical barriers but by autonomous systems (AS): *Wang/Talcott/Jia/Loo/Scedrov* in: BRUNI/DINGEL [2011], *Formal Techniques for Distributed Systems*, p. 335.

[96] Hereinafter abbreviated as »SAAS«.

[97] Hereinafter abbreviated as »PAAS«.

[98] Hereinafter abbreviated as »IAAS«.

[99] E.g. LANDY/MASTROBATTISTA [2008], *The IT / Digital Legal Companion*, p. 352 for SaaS.

[100] *Mahmood* in: MAHMOOD/HILL [2011], *Cloud Computing for Enterprise Architectures*, p. 7.

[101] The discussed services do not necessarily use the term cloud computing to describe the provided services, however, they might be classified as cloud computing by a third party.

between the analogue and the digital world is leading to various questions concerning the usability and security of handling, storing or distributing information. In the security sensitive area of general aviation the decision of using and/or trusting one or another can mean the difference between a regular flight with a minuscule incident or a tremendous misfortune.

III. Data and information quality

1. Authenticity

One huge challenge of modern communication technology and services is the authenticity of the sender.[102] Where in a telephone call at least the voice of the interlocutor may give or confirm the identity, this will not happen in text-based communication. And since faking an identity is lucrative,[103] well developed tactics like social engineering[104] with spear phishing[105] are being used. If the information emitting source can not be authenticated, an untrusted third party could easily spoof the requested information and therefore compromise the security.

2. Integrity

Although a sender might be authenticated, that does not mean necessarily that the integrity of the data is given.[106] Techniques like Secure Sockets Layer[107] / Transport Layer Security[108] may authenticate the sender and try to secure the integrity of the data on the way of transport.[109] If a user would request a document[110] over SSL/TLS, the integrity of the data on the way of transport would

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[102] As vividly illustrated by STEINER [1993], *On the Internet, nobody knows you're a dog.*, p. 61, a comic strip which is widely recognized, e.g. WIKIMEDIA FOUNDATION [2013], *Wikipedia: On the Internet, nobody knows you're a dog*, <http://en.wikipedia.org/wiki/On_the_Internet,_nobody_knows_you're_a_dog>.

[103] For example in 2012, 15 million Americans were victims to identity theft, totaling in $50 million damages: NOLLKAMPER [2013], *Law Office Management*, p. 321.

[104] For vivid examples of this technique see MITNICK/SIMON [2005], *The Art of Intrusion*.

[105] *Irani/Balduzzi/Balzarotti/Kirda/Pu* in: HOLZ/BOS [2011], *Detection of Intrusions and Malware, and Vulnerability Assessment*, p. 57.

[106] Different point of view, where the authentication invokes integrity checks of data sent: *Lin/Canden* in: FUGINI/BELLETTINI [2004], *Information Security*, p. 285.

[107] Hereinafter abbreviated as »SSL«.

[108] Hereinafter abbreviated as »TLS«.

[109] *Freier/Karlton* in: INTERNET ENGINEERING TASK FORCE [2011], *The Secure Sockets Layer (SSL) Protocol Version 3.0 (RFC 6101)*, <http://tools.ietf.org/html/rfc6101>, in more detail v.i.: B III 3 e bb), *SSL / TLS*, p. 22.

[110] Like HTML for web browsing, XML for easy parsing of the data with an application.

be covered. However, the document itself and the information it contains is outside of the scope of security in this case: if an attacker was able to modify the document, the new spoofed document would be delivered securely. Given such a situation, the data should always have measures to verify the integrity of the data in the data itself, not only in the way of transport.

3. Possible measures to ensure authenticity and/or integrity

To ensure the authenticity and integrity of data, several measures might be used. Some measures are very useful, some are not, and some are even lulling somebody into a false sense of security.

a) Symmetric cryptography

„*Symmetric cryptography is based on algorithms that use a single, shared secret key.*"[111] Therefore, not only needs the encrypted data to be transmitted to the receiver, but also the secret key. „*[A] safe way of data transfer must be used to move the secret key between the sender and the receiver.*"[112] If the secret key is no longer secret (and the algorithm is known)[113], the encryption of the information is compromised. When the key stays secret and the used algorithm is strong, for example when a one-time pad cipher is used[114], the encryption will not be broken. If a weak cipher is utilized, like the Caesar cipher, it can be assumed that the key will be broken very easily.[115] For the purposes of sending information over open and not reliable networks, symmetric cryptography is not advisable, because the key exchange would occur in an unprotected way.

b) Asymmetric cryptography

Asymmetric cryptography is named that way, because the concerned algorithms are using a pair of different keys: one for encryption and one for decryption.[116] This method is also called „*Public-key cryp-*

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[111] STEWART [2013], *Network Security, Firewalls and VPNs*, p. 95.

[112] *Hamamreh* in: ELLEITHY/SOBH [2013], *Innovations and Advances in Computer, Information, Systems Sciences, and Engineering*, p. 216.

[113] That the algorithm is known has to be assumed. If not, relying on security through obscurity is a violation of Kerckhoffs principle, v.i.: B III 3 c bb), *Kerckhoffs' principle*, p. 15.

[114] Very strong but by virtue of some drawbacks not „*perfectly secret*": PARDO [2013], *Introduction to Cryptography with Maple*, pp. 135 et seq.

[115] E.g. for the Caesar cipher with a kind of low-tech frequency analysis (which was still used by the head of the Silician Mafia to message his subordinates in 2006): AARONSON [2013], *Quantum Computing Since Democritus*, p. 94.

[116] STEWART [2013], *Network Security, Firewalls and VPNs*, pp. 96 et seq.

tography".[117] The key for encryption is referred to as the public key, the key for decryption is called private key.[118] In contrast to symmetric cryptography the main advantage is the key exchange: Since the public key for encryption can be used by anyone for encryption and only the private key for decryption needs to stay secret, the public key can be transferred over insecure channels (Diffie-Hellman key exchange).[119] Furthermore, asymmetric cryptography can be used to sign data, ensuring both authenticity[120] and integrity[121] of the data. A signature generated with the private key will be attached and linked to the data, the signature for the given data can be verified using the public key.[122] If the data or the signature is altered, a verification process[123] will fail.[124]

c) Security

aa) Security as a process

„*Security is a process and not a product.*"[125]
Implementing security at any layer must focus on three concepts that shape a security circle of trust: Integrity, availability and confidentially.[126] Dedication to all three points is necessary, although absolute security is and will remain unattainable.[127] „*[T]he goal is to maintain reasonable rather than perfect security.*"[128] However, when it comes to the area of aviation the weighting between the costs of implementing measures to make a flight operation safer in contradiction to the damage and collateral damage caused by a possible incident needs to be well considered.

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[117] E.g. WIKIMEDIA FOUNDATION [2013], *Asymmetric cryptography* redirects „*Asymmetric cryptography*" to „*Public-key cryptography*". For Public-key infrastructures v.i. B III 3 d), *Public key infrastructures*, p. 16.
[118] MARTIN [2012], *Everyday Cryptography*, p. 154.
[119] GALBRAITH [2012], *Mathematics of Public Key Cryptography*, pp. 405 et seq.
[120] V.s. B III 1., *Authenticity*, p. 12.
[121] V.s. B III 2., *Integrity*, p. 12.
[122] PATIL/SZYGENDA [2013], *Security for Wireless Sensor Networks Using Identity-Based Cryptography*, p. 78.
[123] Please note that the verification is most likely not done by hand, v.i. B III 4., *The role of software*, p. 24.
[124] GUPTA/AGARWALA/AGARWAL [2005], *Digital Signature*, p. 49.
[125] Common saying, e.g. KLAUS et al. [2010], *Seven Deadliest Microsoft Attacks*, p. 18; KOCHHAR et al. [2009], *Financial Inclusion*, p. 156 or STANFORD-SMITH/KIDD [2000], *E-business*, p. 188.
[126] SOUTHWICK/MARSCHKE/REYNOLD [2011], *Junos Enterprise Routing*, pp. 342 et seq.
[127] E.g. *Cavelty* in: COLLINS [2013], *Contemporary Security Studies*, p. 366; SUPAN [2012], *The Art and Science of Security*, p. 31 or RICHARDS [2012], *A Guide to National Security*, p. 33.
[128] STEWART [2013], *Network Security, Firewalls and VPNs*, p. 186.

bb) Kerckhoffs' principle

Kerckhoff formulated six maxims[129] in 1883 (*La cryptographie militaire*). The second maxim is expresses that „*[a]n encryption scheme should be secure even if everything about the system, with the exception of the key, is public knowledge*".[130] This maxim is referred to as the Kerckhoffs' principle.[131] The basic idea behind this principle is that „*[t]he enemy knows the system.*"[132] However, it is a common misinterpretation of the principle, that the cryptographic system should or even needs to be known publicly.[133]

cc) Open design

Although an open design of the algorithm or system can have advantages,[134] the openness is no absolute guarantee for the absence of design faults or errors.

One example is the open source software OpenSSL in the versions 0.9.8c-1 to 0.9.8g-9. OpenSSL is „*an open-source implementation of the SSL and TLS protocols*", however, „*Wrappers allowing the use of the OpenSSL library in a variety of computer languages are available*".[135] A maintainer broke the random number generator. The erroneous versions have been distributed since the 17th of September 2006. As a consequence all encrypted data and every key which was generated with a broken version is compromised. Debian reported the error on the 13th of May 2008 and the problem was fixed

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[129] The six maxims, cited from VAN TILBORG/JAJODIA [2011], *Encyclopedia of Cryptography and Security*, p. 675:
„*1. The system must be substantially, if not mathematically, undecipherable.*
2. The system must not require secrecy and can be stolen by the enemy without causing trouble.
3. It must be easy to communicate and remember the keys without requiring written notes, and it must also be easy to change or modify the keys with different participants.
4. The system ought to be compatible with telegraph communication.
5. The system must be portable, and its use must not require more than one person.
6. Finally, regarding the circumstances in which such system is applied, it must be easy to use and must neither require stress of mind nor the knowledge of a long series of rules."

[130] PARDO [2013], *Introduction to Cryptography with Maple*, p. xxix.

[131] E.g. FERGUSON/SCHNEIER/KOHN [2010], *Cryptography Engineering*, p. 24; SMITH [2013], *Elementary Information Security*, p. 62; BASIN/SCHALLER/SCHLAPFER [2011], *Applied Information Security*, p. 3.

[132] CLAUDE ELWOOD SHANNON, cited after PARDO [2013], *Introduction to Cryptography with Maple*, p. xxix.

[133] MARTIN [2012], *Everyday Cryptography*, p. 27.

[134] SMITH [2013], *Elementary Information Security*, pp. 62 et seq.

[135] WIKIMEDIA FOUNDATION [2013], *Wikipedia: OpenSSL*. A variety of cryptographic algorithms is supported by OpenSSL.

shortly afterwards.[136] Even though the OpenSSL source code is open
and the software potentially can be audited by everyone, this major
flaw existed over one and a half years. The downside of an open
design is that in case of such a flaw a potential attacker can find an
error and exploit it, of course without reporting it. A quite recent
example for a flaw in a pseudo random number generator[137] is the
Java Cryptography Architecture[138] on Android devices. Developers
which used the JCA for key generation are advised to explicitly load
entropy from /dev/random or /dev/urandom.[139]

dd) Security through obscurity

„*Security through obscurity is the idea of gaining protection by using
abnormal configurations.*"[140] Not only is this type a clear violation
of Kerckhoffs' principle,[141] the whole security of the goods which are
to be protected relies on the obscurity of the methods used. Security
through obscurity is seen as „*poor security*"[142]. Others argue that
„*there is no such thing as security through obscurity*"[143], since a
method just relying on obscurity gives no security.

d) Public key infrastructures

aa) General information

When asymmetric cryptography[144] is used, the public keys can not
only be transferred through insecure channels, but also stored openly
for the public.[145] This sounds very tempting at first glance and leads
to the problem of the verification of the (publicly offered) public
key.[146] Everyone is able to generate a new key pair. If for example
the storage is insecure, an attacker could replace the original public
key with his own public key, compromising all data that is encrypted
for the faked key. If someone would successfully execute a man-in-

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[136] It has to be mentioned that although the OpenSSL software was repaired, that fix was not able to fix the already generated compromised keys or the already generated compromised encrypted data. All possiby affected keys had to be replaced, data had to be re-encrypted.

[137] Hereinafter abbreviated as »PRNG«.

[138] Hereinafter abbreviated as »JCA«.

[139] KLYUBIN [2013], *Some SecureRandom Thoughts*, <http://android-developers.blogspot.de/2013/08/some-securerandom-thoughts.html>.

[140] STEWART [2013], *Network Security, Firewalls and VPNs*, p. 251.

[141] V.s. B III 3 c bb), *Kerckhoffs' principle*, p. 15.

[142] HARKINS [2013], *Managing Risk and Information Security*, p. 81.

[143] WINTERFELD/ANDRESS [2013], *The Basics of Cyber Warfare*, p. 14.

[144] V.s. B III 3 b), *Asymmetric cryptography*, p. 13.

[145] WORKMAN/PHELPS/GATHEG [2013], *Information Security for Managers*, p. 402.

[146] Idem [2013], *Information Security for Managers*, pp. 402 et seq.

the-middle attack, he could switch the key in the transfer process.[147] Meeting face to face and verifying the keys personally would lead to high transaction costs for the key exchange.[148] To reduce the risk of a man-in-the-middle attack while keeping the transaction costs low, public key infrastructures[149] in the form of trusted third parties are established.[150] The trusted third parties[151] verify the identity of a member and store the corresponding public key.[152] When there are a lot of members involved the transaction costs are much lower if there is a trustworthy TTP involved, which can verify all of the members' identities and keys than to verify each single key to an identity of a given member individually. There are two different general methods of establishing a TTP: A web of trust[153] and certificate authorities[154].

bb) Web of trust

Phil Zimmermann introduced in 1992 with Pretty Good Privacy[155] 2.0[156] a system for the verification, or better trustworthiness, of public keys, without the need of a root authority.[157] Any user within the web of trust is allowed and encouraged to sign keys from a known person; after a verification of the keys, every signing person is at first an even peer within the web of trust.[158] The web of trust defines three trust levels according to the numbers of the ones trusting and their respective trust level: no trust, marginal trust and full trust.[159] To check if a key is trusted within the web of trust, a path between the user of that specific key and the user checking the validity of that key needs to be established.[160] If there is no direct link between the two users an indirect link via persons that are trusted will

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[147] GARZIA [2013], *Handbook of Communications Security*, pp. 154 et seq.
[148] Nevertheless, when technophile people meet anyhow, they might schedule a time for exchanging and verifying the keys personally. This is called a „*Key signing party*": *Perlman* in: BIDGOLI [2006], *Handbook of Information Security*, p. 855.
[149] Hereinafter abbreviated as »PKI«.
[150] *Al-Hamdani* in: NEMATI/YANG [2011], *Applied Cryptography for Cyber Security and Defense*, p. 85.
[151] Hereinafter abbreviated as »TTP«.
[152] BELSON [2002], *Certification Marks*, p. 121.
[153] V.i. B III 3 d bb), *Web of trust*, p. 17.
[154] V.i. B III 3 d cc), *Certificate authorities*, p. 18.
[155] Hereinafter abbreviated as »PGP«.
[156] WIKIMEDIA FOUNDATION [2013], *Wikipedia: Pretty Good Privacy*, <http://en.wikipedia.org/wiki/Pretty_Good_Privacy>.
[157] *Dingledine/Freedman/Molnar* in: ORAM [2001], *Peer-to-peer*, pp. 307 et seq.
[158] *Weis* in: BIDGOLI [2006], *Handbook of Information Security*, pp. 869 et seq.
[159] *Zhou/Harn* in: BARTOLACCI/POWELL [2011], *Interdisciplinary and Multidimensional Perspectives in Telecommunications and Networking*, p. 81.
[160] *Ferraro/O'Mahony* in: PADGETT/POWELL [2012], *The Emergence of Organizations and Markets*, p. 549.

be established, building as much hops (with trusted persons/keys as intermediaries) as necessary.[161] If the small world phenomenon or the six degrees of separation theory are in fact correct, establishing a link will be successful with a maximum of 6 hops.[162] Since some persons might be very well connected, they are gaining authority by trust.[163] The web of trust scheme is not bound to PGP or other cryptography software. It may even be considered how a web of trust could work for physical identity cards.[164]

cc) Certificate authorities

Certificate authorities[165] are publishing their public key as a root element.[166] With their private key they are signing other certificates (public keys), which may or may not be allowed to sign certificates themselves. The certificate that is presented to some user must be (regardless of the number of hops) derived from the initially trusted root CA.

α) X.509

The X.509 standard,[167] which is commonly used for authenticating SSL/TLS connections over HTTPS,[168] is a good example for certificate authorities in PKIs. The current version is described as a proposed standard in RFC 6818,[169] which updates RFC 5280[170].

A root certificate is used to sign derived certificates, the derived certificates are only accepted when the root certificate is seen as trust-

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[161] For Debian: COLEMAN [2013], *Coding Freedom*, p. 143.

[162] POWERS [2003], *Practical RDF*, p. 298; Only with the premise that every human would be in the concerned web of trust.

[163] One example is the „*Heise Zeitschriftenverlag*", which is operating a crypto campaign since 1997 and for that purpose verifying identities within the PGP web of trust: HEISE SECURITY [2013], *Krypto-Kampagne*, <http://www.heise.de/security/dienste/Krypto-Kampagne-2111.html>.

[164] SCHMEH [2009], *Elektronische Ausweisdokumente*, p. 100, though there are serious concerns.

[165] Hereinafter abbreviated as »**CA**«.

[166] BENANTAR [2006], *Access Control Systems*, p. 94.

[167] X.509 („*The Directory: Public-key and attribute certificate frameworks*", ISO/IEC 9594-8) was issued by the ITU-T on the 3rd of July 1988: WIKIMEDIA FOUNDATION [2013], *Wikipedia: X.500*, <http://en.wikipedia.org/wiki/X.500>.

[168] The standard port for HTTPS is 443 in contradiction to the standard port 80 for HTTP.

[169] *Yee* in: INTERNET ENGINEERING TASK FORCE [2013], *Updates to the Internet X.509 Public Key Infrastructure Certificate and Certificate Revocation List (CRL) Profile (RFC6818)*, <http://tools.ietf.org/html/rfc6818>.

[170] *Cooper/NIST/Santesson/Microsoft/Farrell/Trinity College Dublin/Boeyen/Entrust/Housley/Vigil Security/Polk* in: idem [2008], *Internet X.509 Public Key Infrastructure Certificate and Certificate Revocation List (CRL) Profile (RFC 5280)*, <http://tools.ietf.org/html/rfc5280>.

worthy and the chain to the root certificate is in tact.[171] This means that there must be at least one trusted root certificate installed, either by the user himself or within the software that is being used as default.[172] Browsers have a set of root-certificates built in and preconfigured as trusted.[173] For example Mac OS X in the version 10.8.4 has 181 root certificates from a lot of certificate authorities installed. These certificates are being used by the Safari browser.[174] Every single one of the root certificates is able to verify the authenticity of any domain when a connection via HTTPS is going to be established, because all the certificates are equally trustworthy. If the certificate can not be validated with the trusted CAs, a browser will display a warning or error; the user is then free to accept the (not initially) trusted certificate by hand. If a certificate changes and the new certificate is derived from one of the trusted CAs, the user will not be alerted of that change in any form. So when an attacker wants to alter the connection from the user to the server, a certificate issued by a trusted CA will be sufficient because the chance that a user will proof a trusted certificate manually is quite low.

The incident of DigiNotar, a widely trusted CA that was hacked, lead to a fake certificate for *.google.com, with which a proxy for the Google Mail service was set up and approximately 300.000 accounts were compromised.[175] If a certificate is not trusted anymore, it may be revoked with an announcement in a certificate revocation list[176].[177] Nevertheless, in the event of the DigiNotar hack, the CRLs and online certificate status protocol[178] *„did not come to save the day."*[179] From the 1st of April 2015 the maximum period of va-

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[171] *Chen/Chen/Yang/Zhan* in: NEMATI/YANG [2011], *Applied Cryptography for Cyber Security and Defense*, p. 134.

[172] OPPLIGER [2003], *Security Technologies for the World Wide Web*, p. 192.

[173] *Vratonjic/Freudiger/Bindschaedler/Hubaux* in: SCHNEIER [2013], *Economics of Information Security and Privacy III*, p. 80.

[174] To view the certificates the utility „*Keychain access*" needs to be opened, the left tab has an entry for „*System-root*". In Firefox the certificates can be viewed in the Preferences -> Extended -> Encryption -> View certificates.

[175] Targeted were mostly Iranians. A brief overview, including a geographical visualization of the „*Operation Black Tulip*": KEIZER [2011], *Hackers spied on 300,000 Iranians using fake Google certificate*, <http://www.computerworld.com/s/article/9219731/Hackers_spied_on_300_000_Iranians_using_fake_Google_certificate>.

[176] Hereinafter abbreviated as »CRL«.

[177] *Wu* in: KAR/SYED [2011], *Network Security, Administration, and Management*, pp. 101 et seq.

[178] Hereinafter abbreviated as »OCSP«.

[179] SHEMA [2012], *Hacking Web Apps*, p. 254.

lidity for a certificate will be 39 months according to the baseline standards.[180] Browsers like Chrome[181] or Firefox[182] will comply to this.

β) Qualified electronic signatures

The term „*qualified electronic signature*"[183] comes from a german understanding[184] of the regulations concerning the substitution of a handwritten signature of the Directive 1999/93/EC[185]. The Directive states that „*Member States shall ensure that advanced electronic signatures which are based on a qualified certificate and which are created by a secure-signature-creation device […] satisfy the legal requirements of a signature in relation to data in electronic form in the same manner as a handwritten signature satisfies those requirements in relation to paper-based data*", Art. 5 № 1 lit. a) Directive 1999/93/EC. The German signature law defines QES as advanced electronic signatures[186] that „*a) are in the event of the creation based on a valid qualified certificate and b) are created with a secure signature creation device*"[187], § 2 № 3 SigG. To illustrate the necessity of the requirement for the term QES, a look into Art. 42 № 5 lit. b) of Directive 2004/18/EC may be suitable: „*Member States may, in compliance with Article 5 of Directive 1999/93/EC, require that electronic tenders be accompanied by an advanced electronic signature in conformity with paragraph 1 thereof*". This provision can be interpreted in two ways: firstly, that an advanced electronic signature is sufficient and secondly that an advanced electronic signature based on a qualified certificate created by a secure signature creation device is necessary to fulfill the requirement. Since Art. 5 Directive 1999/93/EC does not define the advanced signature or a

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[180] 9.4 and 11.3.: CA/Browser Forum [2011], *Baseline Requirements for the Issuance and Management of Publicly-Trusted Certificates, v.1.0*, <https://www.cabforum.org/Baseline_Requirements_V1.pdf>.

[181] Sleevi [2013], *[cabfpub] Deprecating support for long-lived certificates*, <https://cabforum.org/pipermail/public/2013-August/002135.html>.

[182] Markham [2013], *Bug 908125 - Reject certificates with lifetimes greater than 60 months*, <https://bugzilla.mozilla.org/show_bug.cgi?id=908125>.

[183] Hereinafter abbreviated as »QES«.

[184] Original: „*Qualifizierte elektronische Signatur*".

[185] The outcomes of the Directive 1999/93/EC are being reviewed at the moment, there is a „*[p]roposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on electronic identification and trust services for electronic transactions in the internal market*", COM(2012) 238 final.

[186] As defined in § 2 № 2 SigG.

[187] Original: „*a) auf einem zum Zeitpunkt ihrer Erzeugung gültigen qualifizierten Zertifikat beruhen und b) mit einer sicheren Signaturerstellungseinheit erzeugt werden*".

QES (the article only stipulates the substitution of the handwritten signature and the admissibly of an electronic signature in court) both interpretations are arguably. Depending on the economic impact an authority in a Member State may argue either way.[188] With the term QES those problems of interpretation will not that likely occur. The advanced electronic signature is defined in a technical way in Art. 2 № 2 Directive 1999/93/EC, without the need of a PKI or CA. Therefore, a signature created with PGP is able to fulfill the requirements for an advanced electronic signature[189] (without the possibility of the authentication through the web of trust[190]).

„*Member States shall not make the provision of certification services subject to prior authorisation*", Art. 3 № 1 Directive 1999/93/EC. This means in effect, that there is no limited amount in certificate authorities; the situation is comparable with the X.509 certificate authorities[191]. However, the requirements for a certificate authority issuing qualified certificates are reasonably high and laid down in Annex II Directive 1999/93/EC. For example, the German identity card („*Neuer Personalausweis*"), a machine readable travel document[192], is created as a secure signature creation device, regulated in § 22 PAuswG.[193] Although, as the competent authority for issues regarding the SigG was the „*Bundesnetzagentur für Elektrizität, Gas, Telekommunikation, Post und Eisenbahnen*" according to § 3 SigG assigned, the PKI for the german identity card is set up, operated and monitored by the Bundesamt für Sicherheit in der Informationstechnik.[194]

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[188] Recital № 37 Directive 2004/18/EC elaborates that the directive wants to encourage the use of electronic signatures, in particular advanced electronic signatures. However, for the interpretation of Art. 42 this recital is no decision aid. This recital neither does mention Art. 5 Directive 1999/93/EC nor gives it any hint about the understanding of the linkage to Art. 5 Directive 1999/93/EC.

[189] ERTEL [2007], *Angewandte Kryptographie,* p. 154.

[190] V.s. B III 3 d bb), *Web of trust,* p. 17.

[191] V.s. B III 3 d cc α), *X.509,* p. 18.

[192] Hereinafter abbreviated as »MRTD«.

[193] For the requirements of the identity card as a MRTD read SCHMEH [2009], *Elektronische Ausweisdokumente,* pp. 105 et seq.

[194] The complete outline of the EAC PKI for the new german identity card: BUNDESAMT FÜR SICHERHEIT IN DER INFORMATIONSTECHNIK [2010], *BSI - Technische Richtlinie TR-03128*, <https://www.bsi.bund.de/SharedDocs/Downloads/DE/BSI/Publikationen/TechnischeRichtlinien/TR03128/BSI_TR-03128.pdf?__blob=publicationFile>.

e) Various methods

aa) Checksums

Generating checksums is good for checking the integrity[195] of data after or even while the transportation process. The transmission control protocol[196] for example has a build in checksum of 2 bytes[197] within the TCP-Header as a pseudo-header for maintaining the end-to-end integrity of a transmission.[198] However, checksums are not able to verify the authenticity[199] of data, everyone could alter the data and simply generate a new checksum. If a secret method to generate a checksum would be used in order to generate an authentication effect, that approach would be solely based on security through obscurity[200] and a violation of Kerckhoffs' principle[201].

bb) SSL / TLS

An SSL / TLS connection provides integrity[202] by the use of asymmetric cryptography[203] along the transport of data. Depending on how the used software is configured, the X.509 certificate system[204] can ensure authenticity of the sender. Trusting a wide set of CAs, with no notification whatsoever in an event of a certificate change for an IP-address, may be not the wisest idea. Creating and signing an own certificate, with all the constraints and obstacles that this may produce, is likely to be the „*most honest option*".[205] The use of a perfect forward secrecy is highly recommended for the fact that if the private key of the sender gets compromised, that key is not able to decrypt already sent data which might have been recorded earlier with the use of this provision.[206] If data gets compromised before it is sent, this technique is useless, it only ensures the integrity of the compromised data between sender and receiver.[207]

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[195] V.s. B III 2., *Integrity*, p. 12.
[196] Hereinafter abbreviated as »TCP«.
[197] Equals to 16 bits.
[198] IANNONE [2012], *Telecommunication Networks*, p. 63.
[199] V.s. B III 1., *Authenticity*, p. 12.
[200] V.s. B III 3 c dd), *Security through obscurity*, p. 16.
[201] V.s. B III 3 c bb), *Kerckhoffs' principle*, p. 15.
[202] V.s. B III 2., *Integrity*, p. 12.
[203] V.s. B III 3 b), *Asymmetric cryptography*, p. 13.
[204] V.s. B III 3 d cc α), *X.509*, p. 18.
[205] Original: „*[...] sind selbst-signierte Zertifikate die ehrlichste Variante.*"; VON LEITNER [2010], *Untitled (3rd of October 2010)*, <http://blog.fefe.de/?ts=b 25933c5>.
[206] CHEN/GONG [2012], *Communications System Security*, pp. 256 et seq.
[207] For example cross Site Scripting (XSS) might be a possible attack vector: SNYDER/MYER/SOUTHWELL [2010], *Pro PHP Security*, p. 51.

cc) Digital signatures

Signing data, regardless of the way of transport or publication, ensures both integrity[208] and authenticity[209]. The signature should be linked to the data in that way, that the signature is easily visible and gives a user the opportunity to verify it. The claim from Kerckhoff that the cryptographic system should not require „*stress of mind*"[210] is not to be fulfilled due to the fact that state of the art key lengths need to be computed.[211] Annex II Directive 1999/93/EC gives a good indication about the requirements which should be used for signing data, since the premises for the fulfillment of an advanced electronic signature are laid down there. From the perspective of computing, the advanced electronic signature and the linkage to the concerned data the security is the same as for the QES[212]. The qualified certificate will be as strong as the established PKI/CA, whereas the creation with a secure signature creation device will add security to the signature due to the fact that there is external hardware, running independent software.[213] Although this hardening measure might be appropriate for the substitution of a hand-written signature, the usability suffers. And for the field of real time data, like the emission of in-flight location data, this measure of having to enter a PIN for every data set, is simply impossible.

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[208] V.s. B III 2., *Integrity*, p. 12.

[209] V.s. B III 1., *Authenticity*, p. 12.

[210] V.s. maxim № 6: B III 3 c bb), *Kerckhoffs' principle*, p. 15.

[211] For the minimum key length that is considered to be strong and the differences in processing/computing symmetric and asymmetric cryptography see STEWART [2013], *Network Security, Firewalls and VPNs*, pp. 94 et seq.

[212] Which in addition needs to be derived from a qualified certificate and generated with a secure signature creation device, v.s. B III 3 d cc β), *Qualified electronic signatures*, p. 20.

[213] For the „*CAT-B*" reader category the PIN-pad is optional: BUNDESAMT FÜR SICHERHEIT IN DER INFORMATIONSTECHNIK [2013], *Requirements for Smart Card Readers Supporting eID and eSign Based on Extended Access Control*, p. 7, <https://www.bsi.bund.de/SharedDocs/Downloads/EN/BSI/Publications/TechGuidelines/TR03119/BSI-TR-03119_V1_pdf.pdf?__blob=publicationFile>. This leads to the situation that a trojan horse could log the PIN on the compromised host system; if the identity card will not be removed from the reader and the reader will not be unplugged from the computer, the attacker has full control: CHAOS COMPUTER CLUB [2010], *Praktische Demonstration erheblicher Sicherheitsprobleme bei Schweizer SuisseID und deutschem elektronischen Personalausweis*, <http://www.ccc.de/de/updates/2010/sicherheitsprobleme-bei-suisseid-und-epa>.

4. The role of software

a) Definition of software

The Directive 2009/24/EC[214] offers no definition of software or computer programs[215], even though this directive is for the „*legal protection of computer programs*". The German Bundesgerichtshof has defined software as „*a set of instructions capable, when incorporated in a machine-readable medium, of causing a machine having information-processing capabilities to indicate, perform or achieve a particular function, task or result*"[216]. The limitation to the incorporation in a machine-readable medium sounds narrow, but given the fact that optical character recognition is well developed,[217] a sheet of paper could fulfill this requirement. In addition to that argument, in the early days of software development,[218] up until the 1970s,[219] software was created on and used with punched cards. Therefore, software is a broad term and includes software which is hardcoded into hardware. One example is storing software into an field programmable gate array[220] for the sole purpose of achieving patentability of the software.[221]

b) Code is law

Lessig coined the phrase „*code is law*" in his book „*Code and other laws of cyberspace*" from 1999 in a sense of regulating the actions of cyberspace inhabitants in comparison to state action.[222] State actions in cyberspace are problematic through the occurred dematerialization, detemporalization, deterritorialization and depersonaliza-

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[214] Directive 2009/24/EC is a renewal of Directive 91/250/EEC, the broad protection of computer programs in the EU therefore exists for more than 20 years.

[215] The terms „*software*", „*computer program*" or just „*program*" are being used synonymously in this work.

[216] BGH GRUR 1985, 1041, 1047. Original: „*eine Folge von Befehlen, die nach Aufnahme in einen maschinenlesbaren Träger dazu geeignet sind, zu bewirken, dass eine Maschine mit informationsverarbeitenden Fähigkeiten eine bestimmte Funktion oder Aufgabe oder ein bestimmtes Ergebnis anzeigt, ausführt oder erzielt.*"

[217] E.g. *Mandipati/Asisha/Raj/Chitrakala* in: MEGHANATHAN/NAGAMALAI/ CHAKI [2013], *Advances in Computing and Information Technology*, pp. 215 et seq.

[218] O'REGAN [2012], *A Brief History of Computing*, pp. 204 et seq.

[219] BAYUK et al. [2012], *Cyber Security Policy Guidebook*, p. 16.

[220] Hereinafter abbreviated as »FPGA«.

[221] Software itself is, as laid down by Art. 52 II lit. c) EPC, not patentable „*as such*", Art. 52 III EPC. For the „*borderline between software and hardware*" it may be referred to KLEMENS [2006], *Math You Can't Use*, pp. 63 et seq.

[222] The successor, partly written through a collaborative wiki, was released under the CC-BY-SA 2.5 license: LESSIG [2006], *Code version 2.0*, <http://www.codev2.cc/download+remix/Lessig-Codev2.pdf>.

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tion.[223] These are the basic fundamentals, although not formulated to this extent at that time, which lead Barlow to write a declaration of the independence of cyberspace.[224] In the context of this thesis the use of the phrase code is law is not describing a broad regulatory effect like in the situation between a citizen and the state, but rather the deterministic effect from software on a user in general. The graphical user interface[225], with which a user is interacting, is influencing the actions taken. That a software does what it says it does is a matter of trust and due to possible legal constraints[226] a mistrust may not legally be pursued to the full extent. When for example a website is transferred over a connection that is encrypted with SSL / TLS[227] and the browser accepts the certificate as a derived certificate from a trusted certificate authority,[228] the status bar of the browser will display that process. The simple graphical display of a padlock in the status bar is the only hint a normal user will get, moreover, users are advised to take a close look for the padlock.[229] What is really happening can only be discovered when the software is reverse engineered[230] or the concerned traffic will be analyzed. The Blackberry 10 Smartphone sends the e-mail credentials that are entered into the device to a Blackberry server.[231] After that the Blackberry servers log into the e-mail account.[232] This is done without any technical necessity, in possible breach of Directive 1995/46/EC, and was only discovered because Frank Rieger analyzed the traffic that his Blackberry 10 produced and looked into his mail server log files.[233]

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[223] HOEREN [2000], *Computer Law und Security Report*, p. 113 (pp. 113 et seq).

[224] BARLOW [1996], *A Declaration of the Independence of Cyberspace*, <http://bit.ly/bYUOOH>.

[225] Hereinafter abbreviated as »GUI«.

[226] V.i. B III 4 c), *Copyright issues*, p. 26.

[227] V.s. B III 3 e bb), *SSL / TLS*, p. 22.

[228] V.s. B III 3 d cc α), *X.509*, p. 18.

[229] E.g. EVANS/SCHNEIDER [2009], *The Internet*, p. 61; BIDGOLI [2012], *Management Information System*, p. 88 or *Grover/Berghel/Cobb* in: ZELKOWITZ [2011], *Advances in Computers*, p. 16.

[230] Recommendations for reverse engineering: RIERSON [2013], *Developing Safety Critical Software*, pp. 511 et seq.

[231] The server (68.171.232.33) is located in Canada but the routing goes through the United Kingdom and the USA.

[232] EIKENBERG [2013], *BlackBerry späht Mail-Login aus*, <http://www.heise.de/newsticker/meldung/BlackBerry-spaeht-Mail-Login-aus-1919718.html>.

[233] RIEGER [2013], *Blackberry 10 macht E-Mail-Passworte für NSA und GCHQ zugreifbar*, <http://frank.geekheim.de/?p=2379>.

c) Copyright issues

The rightholder has the exclusive right of reproduction of the computer program by any means and in any form[234], as well as the translation, adaption, arrangement and any other alteration[235] or any form of distribution to the public[236]. The Rightholder is the natural person or group of persons who created the computer program[237], in the latter case the rights will be as the program owned jointly[238]. „*Where a computer program is created by an employee in the execution of his duties or following the instructions given by his employer, the employer exclusively shall be entitled to exercise all economic rights in the program so created, unless otherwise provided by contract*", Art. 2 № 3 Directive 2009/24/EC. The limitation of transfer to economic rights instead of the whole copyright is done because some jurisdictions grant not only economic rights, but also moral rights.[239] These moral rights may be nontransferable.[240] The exceptions in Art. 5 Directive 2009/24/EC to the exclusive usage rights (restricted acts) that the directive to the right holder grants are narrow. Under which circumstances a decompilation of software is legitimate is laid down in Art. 6 Directive 2009/24/EC. The scope of Art. 6 Directive 2009/24/EC is that programmers shall be allowed to achieve interoperability with other computer programs. Every step of decompilation needs to be necessary for achieving this goal, Art. 6 № 1 Directive 2009/24/EC. There is no other usage right or an exception for reverse engineering software regulated in the directive. Even safety-critical software, understood as software that is part of a safety-critical system,[241] relishes full blown copyright protection: an analyzation of the subject matter without a license to do so concludes therefore a copyright infringement.[242] An example for software that had to be reverse engineered for enlightenment and security purposes is the German state trojan horse, which the

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[234] Art. 4 № 1 lit. a) Directive 2009/24/EC.

[235] Art. 4 № 1 lit. b) Directive 2009/24/EC.

[236] Art. 4 № 1 lit. c) Directive 2009/24/EC.

[237] Art. 2 № 1 Directive 2009/24/EC.

[238] Art. 2 № 2 Directive 2009/24/EC.

[239] *Grosheide* in: DERCLAYE [2009], *Research Handbook on the Future of EU Copyright*, pp. 242 et seq.

[240] LANDY/MASTROBATTISTA [2008], *The IT / Digital Legal Companion*, pp. 59 et seq.

[241] RIERSON [2013], *Developing Safety Critical Software*, p. 3.

[242] A legal evaluation in great detail of reverse engineering in Germany and the USA: SCHWEYER [2012], *Die Rechtliche Bewertung des Reverse Engineering in Deutschland und den USA*.

Chaos Computer Club[243] has analyzed after its discovery.[244] Since the CCC did not have the usage right to do so, that results in a copyright infringement.[245] However, it might be arguable to confine the copyright rules because higher fundamental rights are at stake or are already being violated.[246]

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[243] Hereinafter abbreviated as »**CCC**«.

[244] CHAOS COMPUTER CLUB, *Chaos Computer Club analysiert Staatstrojaner*, <http://www.ccc.de/de/updates/2011/staatstrojaner>.

[245] To reverse engineer software at least one copy needs to be loaded into the RAM and copying software is a restricted act.

[246] An overview of the functionality of the German state trojan horse: WEBER/ HEINRICH [2012], *Anonymization*, pp. 58 et seq and some legal implications: Idem [2012], *Anonymization*, pp. 62 et seq.

C. Legal framework and important institutions

Before the invention of heavier than air crafts in the 20[247]th century
legal questions about the usage of air space were only of academic
nature, if they occurred at all. For maritime law as an older domain
in contrast, „*the oldest surviving regulations in northern Europe are
from Scandinavia and date back to the late twelfth century.*"[248] One
of the arising questions was if the seas are to be classified as res
nullius or res communis,[249] a question that also arose for the outer
space later on.[250] The air space directly over a state is under the
sovereignty[251] of that state, whereas the outer space is free to use
by all states.[252] Many states entered bilateral or multilateral agree-
ments concerning air spaces and aviation, binding the sovereignty to
some extent.[253] The use of IT in general aviation will affect public
law as well as private law, though the main concern of safety will be
governed by public law.

I. European Union

Due to the fact that this thesis is focussing on the area within the
borders of the EU, the EU law will be the predominant source of the
legal basis.

Firstly, the fundamental laws will have to be taken into considera-
tion. Fundamental laws may be embedded directly from the primary
law of the EU[254] or are effective because of national legislation[255].
Every interference with a fundamental right must be proportionate.
To fulfill the requirement of proportionality, prohibitory measures
must be „*appropriate and necessary in order to achieve the objectives*

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[247] V.s. A I., *Presentation of the topic*, p. 1.

[248] FRANKOT [2012], *'Of Laws of Ships and Shipmen'*, p. 6.

[249] *Bederman* in: FASSBENDER/PETERS [2012], *The Oxford Handbook of the History of International Law*, p. 362.

[250] BENDER [1998], *Launching and Operating Satellites*, pp. 41 et seq.

[251] For a description of sovereignty in the context of aviation law read ABEYRATNE [2012], *Air Navigation Law*, pp. 1 et seq.

[252] HAANAPPEL [2003], *The Law and Policy of Air Space and Outer Space*, p. 10, also mentioning that the boundary between air space and outer space is not precisely defined. KÁRMÁN stated that the border must be at 83km, because it is aerodynamically not possible to fly in that height anymore: KAIENBURG/ BERGMANN [2013], *Iurratio 2013*, p. 47 (p. 48).

[253] The CONVENTION ON INTERNATIONAL CIVIL AVIATION SIGNED AT CHICAGO ON 7 DECEMBER 1944 has 191 parties: INTERNATIONAL CIVIL AVIATION ORGANIZATION [2011], *Member States*, <http://www.icao.int/MemberStates/>.

[254] E.g. the CFREU according to Art. 6 I TEU.

[255] Due to the fact that the EU has 28 Member States the national laws will not be part of the discussion.

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legitimately pursued by the legislation in question, it being understood that when there is a choice between several appropriate measures recourse must be had to the least onerous, and the disadvantages caused must not be disproportionate to the aims pursued."[256]

Secondly, all the laws laid down by the EU need to be taken into consideration because of the competence given by the Member States in the TFEU and TEU.

1. Treaty on the functioning of the European Union

The empowerment of the EU for measures concerning aviation is laid down in Art. 100 II TFEU: „*The European Parliament and the Council, acting in accordance with the ordinary legislative procedure, may lay down appropriate provisions for sea and air transport. They shall act after consulting the Economic and Social Committee and the Committee of the Regions.*"[257] This competence was introduced in the Treaty on European Union (Maastricht treaty) from the 7th of February 1992 in the amended version from the Amsterdam treaty, signed on the 2nd of October 1997 (former Art. 80 II).[258]

2. Charter of fundamental rights of the European Union in conjunction with the treaty on the European Union

The fundamental rights of the CFREU that may be touched by the field of aviation are Art. 2 (Right to life), Art. 3 (Right to the integrity of the person), Art. 15 (Freedom to choose an occupation and right to engage in work), Art. 16 (Freedom to conduct a business), Art. 17 (Right to property) and Art. 45 (Freedom of movement and of residence). These fundamental rights are recognized by the EU according to Art. 6 I TEU. They are also formulated necessarily, sufficiently precise, ordering the immediate effect themselves and another measure by the EU is not required. Therefore, the norms are directly affecting EU citizens.[259] This can lead to a consistent interpretation of secondary law with primary law[260] or even to a inapplicability of national law[261].

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[256] ECJ Case C-331/88.

[257] For an overview about the background of this provision it may be referred to: *Giemulla/Schyndel/Donato* in: GIEMULLER/WEBER [2011], *International and EU Aviation Law*, pp. 137 et seq.

[258] *Waldinger* in: WALD/FAY/GLEICH [2007], *Aviation Management*, p. 99.

[259] FRENZ [2010], *Handbuch Europarecht Bd. 5*, p. 8.

[260] E.g. for labor law: WILLEMSEN/SAGAN [2011], *NZA 2011*, p. 258 (pp. 261 et seq).

[261] Idem [2011], *NZA 2011*, p. 258 (p. 262).

3. European convention on human rights and its protocols

Aviation concerned fundamental rights of the ECHR and its protocols are Art. 2 ECHR (Right to life), Art. 1 ECHR protocol (Protection of property) and Art. 2 ECHR protocol № 4 (Freedom of movement). „*Fundamental rights, as guaranteed by the [ECHR] [...] shall constitute general principles of the Union's law*", Art. 6 III TEU.

4. Universal declaration of human rights

The UDHR was adopted on the 10th of December 1948 by the United Nations General Assembly.[262] All of the Member States of the EU are members of the UN.[263] Nevertheless, the legal status of the UDHR „*remains that of a non-binding declaration*", being „*no more than a statement of ethical duty at best*".[264] Given that situation, the UDHR will not be a part of the examination.

5. Single European Sky

The Single European Sky[265] is a term that describes the intention of the EC to implement several legal frameworks. The initial idea to create a SES for ATM over the area of the EU was proposed by the EC in 1999.[266] The idea challenged the former fact that „*47 [Air Traffic Control]*[267] *providers (civil and military) operate 58 ATC centres using 22 operating systems and 30 programming languages.*"[268] Goal of the SES initiative is to „*redesign the European sky according to traffic flows rather than national borders*"[269], thus „*tripling capacity and halving air traffic costs*"[270]. SES legal frameworks came in packages and are referred to as SES I, SES II[271] and SES II+.[272]

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[262] Resolution 217A(III): LEE [1999], *The International Criminal Court*, p. 2.
[263] UNITED NATIONS [2006], *UNITED NATIONS MEMBER STATES*, <http://www.un.org/News/Press/docs/2006/org1469.doc.htm>.
[264] *Muchlinski* in: MUCHLINSKI/ORTINO/SCHREUER [2008], *The Oxford Handbook of International Investment Law*, p. 657.
[265] Hereinafter abbreviated as »SES«.
[266] INTERNATIONAL AIR TRANSPORT ASSOCIATION [2013], *Fact Sheet: Single European Sky (SES)*, <http://www.iata.org/pressroom/facts_figures/fact_sheets/pages/ses.aspx>.
[267] Hereinafter abbreviated as »ATC«.
[268] HOLLOWAY [2008], *Straight and Level*, p. 247.
[269] ALEMANNO [2011], *Governing Disasters*, p. 7.
[270] KALLAS [2013], *SINGLE EUROPEAN SKY: 10 YEARS ON AND STILL NOT DELIVERING*, <http://ec.europa.eu/commission_2010-2014/kallas/headlines/news/2012/10/ses_en.htm>.
[271] SES II may also be referred to as „*Single Sky Package*", e.g. ALEMANNO [2011], *Governing Disasters*, p. 191.
[272] SES legislation: CIVIL AVIATION AUTHORITY [2013], *SES Legislation*, <http://www.caa.co.uk/default.aspx?catid=952&pagetype=90&pageid=9436>.

The SES I legislative package, adopted in 2004, consists of a framework regulation (Regulation (EC) No 549/2004), a service provision regulation (Regulation (EC) No 550/2004), an airspace regulation (Regulation (EC) 551/2004) and an interoperability regulation (Regulation (EC) No 552/2004).

SES II is amending, not replacing, SES I with Regulation (EC) 1070/2009.[273] In total, the SES II framework package consists of „*more than 20 Implementing Rules and Community Specifications*".[274] The four pillars of SES II are the Performance Scheme, the FABs, the Network Manager and the Charging Regulation.[275] The competences of the EASA[276] were extended to ATM and aerodromes.[277] In comparison to the USA, the EU is handling less traffic (9.5 million to 15.9 million) with more staff (57.000 to 35.200) although the controlled flight hours are much less (13.8 million to 23.4 million).[278] The EC „*has been leveraging the volcanic ash crisis to create political momentum*" in order to „*accelerate the full implementation*" of the SES II framework.[279] However, the implementation of the SES II package progresses slowly.[280] The airspace is adding an extra 42km for an average flight and actions to solve the problems need to be taken, due to the extra costs of € 5 billion each year that originate from this fragmentation.[281] To redefine the SES II package and in order to speed up the adaptation, the EC has proposed a SES II+ framework package.[282] SES II+ outcomes are arguable and even led to an union-organized strike because an adaptation of SES 2+

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[273] EUROPEAN UNION [2008], *Single European Sky Second Package (SES II) - Q&A*, <http://europa.eu/rapid/press-release_MEMO-08-432_en.htm>.

[274] EUROPEAN COMMISSION [2012], *Single European Sky*, <http://ec.europa.eu/transport/modes/air/single_european_sky/>.

[275] Idem [2012], *Single European Sky II*, <http://ec.europa.eu/transport/modes/air/single_european_sky/ses_2_en.htm>.

[276] V.i. C I 6., *European Aviation Safety Agency*, p. 32.

[277] In Regulation (EC) No. 1108/2009. Idem [2012], *Single European Sky II*, <http://ec.europa.eu/transport/modes/air/single_european_sky/ses_2_en.htm> is mentioning a „*Regulation (EC) No. 1808/2009*" as the legal basis. Unfortunately, there is no regulation with the number 1808 from 2009.

[278] INTERNATIONAL AIR TRANSPORT ASSOCIATION [2013], *A Blueprint for the Single European Sky*, p. 7, <http://www.iata.org/pressroom/pr/Documents/blueprint-single-european-sky.pdf>.

[279] ALEMANNO [2011], *Governing Disasters*, p. 7.

[280] CRESPO/DE LEON [2011], *Achieving the Single European Sky*, p. 180.

[281] KALLAS [2013], *SINGLE EUROPEAN SKY: 10 YEARS ON AND STILL NOT DELIVERING*, <http://ec.europa.eu/commission_2010-2014/kallas/headlines/news/2012/10/ses_en.htm>.

[282] EUROPEAN COMMISSION [2013], *Single European Sky 2+*, <http://ec.europa.eu/transport/modes/air/single_european_sky/ses2plus_en.htm>.

„would jeopardize safety and the number and quality of jobs".[283] This is not really surprisingly though because reducing costs and making the European airspace more efficient was and still is a major concern of the SES implementations directly from the beginning.[284]

6. European Aviation Safety Agency

a) Core principles

The EASA, which was created in 2002 by the Regulation (EC) No. 1592/2002 and whose current[285] direct legal fundamental basis is the Regulation (EC) No. 216/2008,[286] is set up with regulatory and executive tasks within the field of aviation safety for the EU. One achievement of the establishment of the EASA is that the EU regulations are directly binding to all Member States, in contrast to former solutions in which the rules had to be transposed to national law first to be applicable.[287] To achieve this, the execution of secondary EU law was transferred to the external entity EASA, whereby the EASA itself has not the competence to adopt legally binding acts directly.[288]

b) Member States

The EASA has 32,[289] whereas the EU has only 28 Member States.[290] This is possible due to the provision of Art. 66 Regulation (EC) No. 216/2008 which stipulates that the EASA should be open to participation by European third countries. Iceland, Liechtenstein, Norway and Switzerland have made use of this said provision and are members of the EASA Management Board without voting rights.[291] When the EASA has finalized its opinion regarding a legislative act,

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[283] TURNER [2013], *Unions mobilise to halt further European reform*, <http://www.airtrafficmanagement.net/2013/06/unions-mobilise-to-halt-further-european-reform/>.

[284] LEWIS/WITKOWSKY [2004], *Transforming Air Traffic Management*, p. 13.

[285] Regulation (EC) No. 216/2008 has replaced Regulation (EC) No. 1592/2002.

[286] In european aviation law context also referred to as „*Basic Regulation*" (e.g. BUSUIOC [2013], *European Agencies*, p. 121; CRAIG [2012], *EU Administrative Law*, p. 161; HISSLER [2011], *Conditions for an airport operator to make use of an advanced surface movement guidance and control system (A-SMGCS) for the provision of apron management service*, p. 47).

[287] KLUSSMANN/MALIK [2004], *Lexikon der Luftfahrt*, p. 65.

[288] FRITZSCHE [2007], *Das europäische Luftverkehrsrecht und die Liberalisierung des transatlantischen Luftverkehrsmarktes*, p. 159.

[289] EUROPEAN AVIATION SAFETY AGENCY [2013], *EASA Member States*, <https://www.easa.europa.eu/links.php>.

[290] EUROPEAN UNION [2013], *Member countries of the European Union*, <http://europa.eu/about-eu/countries/member-countries/>.

[291] EUROPEAN AVIATION SAFETY AGENCY [2013], *EASA Member States*, <https://www.easa.europa.eu/links.php>.

the EASA will forward the proposal to the EC which then consults the Member States and adopts the implementing rules by qualified majority voting.[292]

c) Functions and tasks

As the three important missions of the EASA are suggesting, the expertise level of the EASA is quite wide: gathering and dissemination information that the EU can draft new legislation, implementation and monitoring of safety rules and regulatory duties like certification of components.[293] In 2008 the EASA has certified the Airbus A380, therefore, there was no need for certifications or authorizations from the single Member States.[294] The statutory basis to fulfill its missions are nine EU regulations, every regulation covers a different part of aviation and shaping details of the legislation even further with additional annexes.[295] The regulations cover initial airworthiness,[296] continuing airworthiness,[297] air crew,[298] air operations,[299] air navigations services[300] common requirements,[301] ATM ANS safety oversight,[302] air traffic control licensing,[303] airspace usage requirements[304] and standardized european rules of air[305].

One of the concerns of SES II[306] was to establish a „*single safety framework for Europe [...] improving the safety level alongside the increase in air traffic*"[307] reshaping and adjusting the tasks, responsibility and functionality of the EASA. The EASA clearly approved this extension of duties and power in an opinion statement from 2008.[308] Furthermore the EASA shall, where appropriate, „*issue*

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[292] House of Commons Transport Committee [2013], *Flight time limitations*, p. 77.

[293] Abeyratne [2012], *Strategic Issues in Air Transport*, p. 152.

[294] Hatzopoulos [2012], *Regulating Services in the European Union*, p. 319.

[295] European Aviation Safety Agency [2013], *Rulemaking Regulations*, <https://www.easa.europa.eu/regulations/regulations-structure.php>.

[296] Commission Regulation (EU) No 748/2012.

[297] Commission Regulation (EU) No 2042/2003.

[298] Commission Regulation (EU) No 1178/2011.

[299] Commission Regulation (EU) No 965/2012.

[300] Hereinafter abbreviated as »ANS«.

[301] Commission Implementing Regulation (EU) No 1035/2011.

[302] Commission Implementing Regulation (EU) 1034/2011.

[303] Commission Regulation (EU) No 805/2011.

[304] Commission Implementing Regulation (EU) No 1332/2011.

[305] Hereinafter abbreviated as »SERA«. Commission Implementing Regulation (EU) No 923/2012.

[306] V.s. C I 5., *Single European Sky*, p. 30.

[307] House of Commons Transport Committee [2009], *The use of airspace*, p. 22.

[308] OPINION NO 1/2008 OF THE EUROPEAN AVIATION SAFETY AGENCY of 15 April 2008 for amending Regulation (EC) No 216/2008 of the European

certification specifications and acceptable means of compliance[309]*, as well as any guidance material*[310] *for the application of this Regulation and its implementing rules*", Art. 18 lit. c) Regulation (EC) No 216/2008.[311] The comprehensive AMC and GMs[312] are non-binding, however, the EASA states that „*there is a presumption that you comply with the rules, and competent authorities will recognise that compliance without the need for any further demonstration of compliance from your side. If you choose to use alternative means to comply with the rule, you will need to demonstrate compliance with the rule to your competent authority. The burden of proof of compliance rests fully with you.*"[313] This shift of the burden of proof has no legal basis in the Regulation (EC) 216/2008. If material has to be applied by a Member State, the EASA has to establish a procedure for consulting the member states, Art. 52 № 2 Regulation (EC) 216/2008. In addition the EASA shall, in the development process of AMC and GMs, „*draw on expertise available in the aviation regulatory authorities of Member States*", Art. 52 № 1 lit. a) Regulation (EC) 216/2008. Therefore ensuring compliance[314] to the AMC and the GMs is likely to also be compliant to the opinion of the concerned competent authority. Additionally Art. 18 lit. c) Regulation (EC) 216/2008 stipulates that the EASA takes „*appropriate decisions for the application of Articles 20, 21, 22, 23, 54 and 55*".[315]

Parliament and of the Council on common rules in the field of civil aviation and establishing a European Aviation Safety Agency, and repealing Council Directive 91/670/EEC, Regulation (EC) No 1592/2002 and Directive 2004/36/EC.

[309] Hereinafter abbreviated as »**AMC**«.

[310] Hereinafter abbreviated as »**GM**«.

[311] Recital № 22 Regulation (EC) No 216/2008 elaborates even further that „*[the EASA] should be able to issue certification specifications and guidance material and to make technical findings and issue certificates as required, it should assist the Commission in monitoring the application of this Regulation and of its implementing rules, and it should be given the necessary authority to carry out its tasks*".

[312] EUROPEAN AVIATION SAFETY AGENCY [2013], *Acceptable Means of Compliance and Guidance Material*, <http://easa.europa.eu/agency-measures/acceptable-means-of-compliance-and-guidance-material.php>.

[313] Idem [2013], *Acceptable Means of Compliance (AMCs) and Alternative Means of Compliance (AltMOCs) - FAQ*, <http://easa.europa.eu/rulemaking/faq/acceptable-and-alternative-means-of-compliance-AMCs-and-AltMOCs-FAQ.php>.

[314] For an in depth analyzation of the term „*compliance*" it may be referred to KAIENBURG [2010], *Compliance in High Profile-Fällen der WTO*, pp. 10 et seq.

[315] The decisions are recognizable online: EUROPEAN AVIATION SAFETY AGENCY [2013], *Agency Decisions*, <http://www.easa.europa.eu/agency-measures/agency-decisions.php>.

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C I 7. Functional airspace blocks

7. Functional airspace blocks

There are efforts to establish functional airspace blocks[316] within the EU to contain the fragmentation of the airspace and „*to provide airspace users in a seamless European airspace with the highest level of safety*"[317]. FAB „*means an airspace block based on operational requirements, reflecting the need to ensure more integrated management of the airspace regardless of existing boundaries*", Art. 2 № 25 Regulation (EC) No. 549/2004. One of the blocks is the Functional Airspace Block Europe Central[318] that covers Belgium, France, Germany, Luxembourg, the Netherlands and Switzerland.[319] This block must not be confused with the Functional Airspace Block Central Europe[320], covering Austria, Bosnia & Herzegovina, Croatia, Czech Republic, Hungary, Slovakia and Slovenia.[321] The vision of FABEC, which is covering a size of 1.713,442 km^2,[322] is that „*[t]he six States regulate and supervise a seamless FABEC airspace and ATM service provision 'as one'*", including „*one safety management system*".[323] The FABEC-entity will be set up as an air navigation service provider[324] by treaty from the states involved, constituting a top-down-institutional model.[325] The other FABs are:[326] Baltic FAB[327], Danish - Swedish FAB[328], North European FAB[329], FAB UK-Ireland[330], Danube FAB[331], South West FAB[332] and FAB Blue MED[333].

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[316] Hereinafter abbreviated as »FAB«.
[317] FABEC [2010], *Mission & Vision*, <http://www.fabec.eu/fab/internet_2010/englisch/inhalt/about_us/mission_vision/index.html>.
[318] Hereinafter abbreviated as »FABEC«.
[319] EUROPEAN UNION [2010], *Belgium, France, Germany, Luxembourg, the Netherlands and Switzerland sign agreement towards the Single European Sky*, <http://europa.eu/rapid/press-release_IP-10-1648_en.htm>.
[320] Hereinafter abbreviated as »FAB CE«.
[321] FAB CENTRAL EUROPE [2013], *Welcome to FAB Central Europe*, <http://www.fab-ce.eu>.
[322] DEUTSCHE FLUGSICHERUNG [2013], *FABEC - FAB Europe Central*, <http://www.dfs.de/dfs_homepage/de/Europa/FABEC/>.
[323] FABEC [2010], *Mission & Vision*, <http://www.fabec.eu/fab/internet_2010/englisch/inhalt/about_us/mission_vision/index.html>.
[324] Hereinafter abbreviated as »ANSP«.
[325] *Wit/Fukken/Riemens/Deleu* in: CRESPO/DE LEON [2011], *Achieving the Single European Sky*, pp. 22 et seq.
[326] According to SKYBRARY [2011], *Functional Airspace Block (FAB)*, <http://www.skybrary.aero/index.php/Functional_Airspace_Block_(FAB)>.
[327] Lithuania and Poland.
[328] Denmark and Sweden.
[329] Estonia, Finland, Iceland, Latvia, Norway.
[330] United Kingdom and Ireland.
[331] Bulgaria and Romania.
[332] Portugal and Spain.
[333] Cyprus, Greece, Italy and Malta.

8. Single European Sky Air Traffic Management Research Programme

The Single European Sky Air Traffic Management Research Programme[334] is a joint undertaking that brings all participants in european aviation together to carve out state-of-the-art and innovative technology „*to optimize the use of airspace, to reduce delays, and to improve the overall safety performance of the European ATM system*".[335] Its legal personality is established by Art. 2 № 1 Council Regulation (EC) No 219/2007[336], the founding members are the European Community, represented by the EC, and EUROCONTROL[337], Annex Art. 1 № 1 Council Regulation (EC) No 219/2007. SESAR has three defined phases: the definition phase (2006-2008), the development phase (2008-2016) and the deployment phase (2013-2025).[338] In aiming to accomplish „*10-fold increase in safety, 3-fold increase in capacity and 50 percent reduction in ATM costs per flight*" the „*ATM Master Plan*" is consisting of five key features to achieve a paradigm shift.[339] All of these five key features are oriented towards exploiting a better usage of real-time in-flight data with more automatization in a dynamic management to accomplish the given goals. 2500 experts are working together filling the € 2.1 billion SESAR project with life.[340]

9. EUROCONTROL

EUROCONTROL, the European Organisation for the Safety of Air Navigation, is providing ATM services for its 39 member states and is an integral part of the SES[341] framework.[342] As a civil-military intergovernmental organization it was established with the EUROCONTROL International Convention relating to Co-operation for the Safety of Air Navigation signed in 1960; the revised convention (Protocol consolidating the EUROCONTROL Convention) dates back to 1997.[343] The European Community will become a full

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[334] Hereinafter abbreviated as »SESAR«.

[335] *Nieto/Valdés* in: Landry [2013], *Advances in Human Aspects of Aviation*, p. 291.

[336] Amended by Council Regulation (EC) No 1361/2008.

[337] V.i. C I 9., *EUROCONTROL*, p. 36.

[338] Abeyratne [2012], *Air Navigation Law*, p. 226.

[339] *Nieto/Valdés* in: Landry [2013], *Advances in Human Aspects of Aviation*, p. 291.

[340] Ky [2012], *The future of Air Traffic Management*, p. 39 (pp. 39 et seq).

[341] V.s. C I 5., *Single European Sky*, p. 30.

[342] Dalamagkidis/Valavanis/Piegl [2012], *On Integrating Unmanned Aircraft Systems into the National Airspace System*, p. 66.

[343] EUROCONTROL [2013], *Legal framework*, <http://www.eurocontrol.int/articles/legal-framework>.

EUROCONTROL member (the ratification process is up and running) and the EC is already working very close with EUROCONTROL so that the SES Initiative is benefitting from the technical expertise of EUROCONTROL.[344] Most of the members of EUROCONTROL are in fact Member States of the EU, so that these actors are not truly independent, but still independent in relation to international law.[345] The tasks according to Art. 2 № 1 of the revised convention are quite comprehensive and include in similarity to SESAR[346] research obligations, for example „*the implementation of a uniform European air traffic management system*", lit. d). Furthermore, it has the duty to „*establish, bill and collect the route charges on behalf of the Contracting Parties*"[347], Art. 2 № 1 lit. q). EUROCONTROL may be subject to jurisdiction by the ECJ, however, it does not qualify as an undertaking resulting in the fact that the route charges billed to airline companies are not revisable by competition law.[348] If an aircraft owner has not paid the route charges owed to EUROCONTROL, EUROCONTROL is still „*required to provide navigation control in that air space*".[349]

II. International Civil Aviation Organization

In the Paris Convention from 1919 it was made clear that „*[t]he High Contracting Parties recognize that every Power has complete and exclusive sovereignty over the air space above its territory*" and the International Commission for Air Navigation[350] was established.[351] Thirty-eight states participated in the discussions evolving around the Paris Convention, twenty-six signed the convention and it came into force by 1922.[352] ICAN is the predecessor of the on the 7th of December 1944 at the Convention on International Civil Aviation in Chicago founded ICAO.[353]

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[344] EUROPEAN COMMISSION [2012], *Co-operation with EUROCONTROL*, <http://ec.europa.eu/transport/modes/air/single_european_sky/co-operation_eurocontrol_en.htm>.

[345] For a comprehensive analyzation of the relationship between the EU and EUROCONTROL it may be referred to: ANTWERPEN [2008], *Cross-border Provision of Air Navigation Services with Specific Reference to Europe*, pp. 71 et seq.

[346] V.s. C I 8., *Single European Sky Air Traffic Management Research Programme*, p. 36.

[347] Only for the ones participating in the route charges system (Annex IV).

[348] WENDT [2013], *EU Competition Law and Liberal Professions*, pp. 111 et seq.

[349] MARESCA [2013], *Regulation of Infrastructure Markets*, p. 121.

[350] Hereinafter abbreviated as »**ICAN**«.

[351] MILDE [2008], *essential air and space law*, p. 11.

[352] *Thibeault* in: DAVIS et al. [2008], *Fundamentals of Aerospace Medicine*, p. 684.

[353] PRICE/FORREST [2013], *Practical Aviation Security*, p. 92.

ICAO is working „*to achieve its vision of safe, secure and sustainable development of civil aviation through the cooperation of its Member States*"[354] and since 2011 it is uniting 191 Member States[355]. Legal powers of the ICAO does not only come through the states entering the Chicago Convention, the ICAO „*does not only derive implied authority from its Contracting States based on universality but it also has attribution from States to exercise certain powers.*"[356] Acts performed by the ICAO, as long as they are not prohibited by the Chicago Convention, must therefore be considered to be legally valid.[357] It is established that the ICAO is issuing minimum safety standards[358] that the member states may exceed (to the extent that the freedoms that are guaranteed are not violated). Nevertheless, the relationship between the ICAO and EASA[359] in terms of power, when a disagreement in regulations occurs, might not be as clear as it should be. Given that states[360] may refuse to acknowledge EASA documents and regulations in case they are not compliant to the ICAO regulations, the ICAO is „*indispensable for the global operation of aircraft within the safety oversight equation*".[361]

III. International Air Transport Association

The IATA was founded 1945 in Havanna, Cuba one year after the establishment of the ICAO[362], being the modern successor to the International Air *Traffic* Association which was founded in 1919 in The Hague.[363] Representing about 240 airlines in 2013[364], the IATA was in the early years only open for airlines with scheduled charter services until it opened for all charter companies in the year 1975[365], thus also representing general aviation companies. The aim of the IATA is the „*promotion of safe, economic and scheduled air trans-*

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[354] INTERNATIONAL CIVIL AVIATION ORGANIZATION [2013], *Vision and Mission*, <http://www.icao.int/about-icao/Pages/vision-and-mission.aspx>.
[355] Idem [2011], *Member States*, <http://www.icao.int/MemberStates/>.
[356] ABEYRATNE [2012], *Aeronomics and Law*, p. 167.
[357] Idem [2012], *Aeronomics and Law*, p. 167 citing SEYERSTEDT.
[358] LARSEN/GILLICK/SWEENEY [2012], *Aviation Law*, p. 1043.
[359] V.s. C I 6., *European Aviation Safety Agency*, p. 32.
[360] Outside of the territory of the EASA Member States.
[361] ABEYRATNE [2012], *Strategic Issues in Air Transport*, p. 153.
[362] V.s. C II., *International Civil Aviation Organization*, p. 37.
[363] ROBINSON/LÜCK/SMITH [2013], *Tourism*, p. 99.
[364] INTERNATIONAL AIR TRANSPORT ASSOCIATION [2013], *Strong Passenger Growth Trend Continues*, <http://www.iata.org/pressroom/pr/Pages/2013-07-03-01.aspx>.
[365] SCHMAUCH [2012], *EU Law on State Aid to Airlines*, p. 24.

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ports".[366] It is the „*most important international governing body in air traffic.*"[367] Although its undisputed factual influence, the IATA is a trade group[368] with no legislative powers.

IV. Joint aviation authorities

The Joint Aviation Authorities[369] are founded as a council of the European Civil Aviation Conference in 1970.[370] The JAA dispersed in 2009 and many of the duties were transferred to the EASA.[371] There were several[372] non-EU members gathered in the JAA.[373] With the introduction of the EASA some non-EU members of the JAA became non-voting members of the EASA[374], while others were completely excluded from the legislative and executive process[375].

V. Bilateral Aviation Safety Agreement

„*COMMITTED to developing a comprehensive system of regulatory cooperation in civil aviation safety and environmental testing and approvals based on continuous communication and mutual confidence*" the EU entered a Bilateral Aviation Safety Agreement with the US.[376] BASA is enhanced by the Implementation Procedures of Airworthiness.[377] This agreement is a technical agreement ensuring the mutual recognition of certified products.[378] Thus things approved by the Federal Aviation Administration[379] are acknowledged as approved as within the EU.

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[366] Original: „*Förderung des sicheren, planmäßigen und wirtschaftlichen Lufttransports*": KLUSSMANN/MALIK [2004], *Lexikon der Luftfahrt*, p. 133.

[367] GUNTHER/RATLIFF/SYLLA [2012], *Airline Distribution*, p. 163 (p. 169).

[368] VOLPE [2008], *Aviation Security Dictionary*, p. 94.

[369] Hereinafter abbreviated as »JAA«.

[370] KLUSSMANN/MALIK [2004], *Lexikon der Luftfahrt*, p. 140.

[371] CONRADY/FICHERT/STERZENBACH [2013], *Luftverkehr*, p. 24.

[372] Albania, Armenia, Azerbaijan, Bosnia and Herzegovina, Georgia, Iceland, Macedonia, Moldova, Montenegro, Monaco, Norway, Serbia, Switzerland, Turkey & Ukraine.

[373] WIKIMEDIA FOUNDATION [2013], *Wikipedia: Joint Aviation Authorities*, <http://en.wikipedia.org/wiki/Joint_Aviation_Authorities>.

[374] EUROPEAN AVIATION SAFETY AGENCY [2013], *EASA Member States*, <https://www.easa.europa.eu/links.php>.

[375] SIEDENBURG/ROODENBURG [2009], *Joint Aviation Authorities (JAA) and European Aviation Safety Agency (EASA) - Medical Requirements for Pilots in Europe*, p. 53 (pp. 66 et seq).

[376] As stated in the BASA Preamble. Such agreements with the USA were also entered by the Member States.

[377] Hereinafter abbreviated as »IPA«. In more detail: HINSCH [2012], *Industrielles Luftfahrtmanagement*, p. 42.

[378] FLORIO [2011], *Airworthiness*, p. 122.

[379] Hereinafter abbreviated as »FAA«.

D. Briefing

I. Content

„Before beginning a flight, the pilot-in-command[380] *of an aircraft shall become familiar with all available information appropriate to the intended operation. Pre-flight action for flights away from the vicinity of an aerodrome, and for all IFR flights, shall include a careful study of available current weather reports and forecasts, taking into consideration fuel requirements and an alternative course of action if the flight cannot be completed as planned*", SERA.2010 Annex to Commission Implementing Regulation (EU) No 923/2012.[381] There are no AMC or GMs issued by the EASA concerning SERA.2010.[382]

1. Premises

a) Flight rules

At first the appropriate flight rules for the concerned intended operation need to be determined. A flight can be conducted under visual flight rules[383] or instrument flight rules[384], provided that the pilot fulfills the appropriate requirements of the flight crew licensing.[385] General aviation covers as well flights under VFR as flights under IFR.[386] A flight under IFR can be conducted under visual meteorological conditions[387] as well as under instrument meteorological conditions[388] whereas a flight under VFR may only be conducted under VMC.[389] Wether VMC minima are met, depends on the altitude band, airspace class, flight visibility and the distance from

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[380] Hereinafter abbreviated as »PIC«.

[381] It will not be noted hereinafter that the SERA are incorporated in the Annex of Commission Implementing Regulation (EU) No 923/2012.

[382] In Annex to ED Decision 2013/013/R.

[383] Hereinafter abbreviated as »VFR«.

[384] Hereinafter abbreviated as »IFR«.

[385] Hereinafter abbreviated as »FCL«. Details to the instrument rating can be found in FCL.600 et seq Annex I Commission Regulation (EU) No 1178/2011.

[386] V.s. B I., *General aviation*, p. 4.

[387] Hereinafter abbreviated as »VMC«. *„[V]isual meteorological conditions mean meteorological conditions expressed in terms of visibility, distance from cloud, and ceiling, equal to or better than specified minima.*", Art. 2 № 142 Commission Implementing Regulation (EU) No 923/2012.

[388] Hereinafter abbreviated as »IMC«. *„[I]nstrument meteorological conditions mean meteorological conditions expressed in terms of visibility, distance from cloud, and ceiling, less than the minima specified for visual meteorological conditions.*", Art. 2 № 91 Commission Implementing Regulation (EU) No 923/2012.

[389] *„When determining whether to operate in accordance with the visual flight rules or the instrument flight rules, a pilot may elect to fly in accordance with instrument flight rules in visual meteorological conditions, or may be required to do so by the competent authority*", GM1 SERA.2005(b).

clouds as laid down by SERA.5001. Special requirements deviant to the general VMC are postulated in SERA.5005 and SERA.5010.[390] Generally speaking, a pilot flying VFR is flying trusting the eyes. A pilot flying IFR is trusting his instruments. In order to be able to trust instruments, it is an obvious premise that instruments must be there in the first place, and are operational. Hence there is a classification distinguishing between VFR-equipped planes and IFR-equipped planes.

b) Airspace structure

The airspace is divided into different zones which are defined in three dimensions.[391] Contrary to national borders that are defined at surface level,[392] the definition of an airspace zone can start at any height.
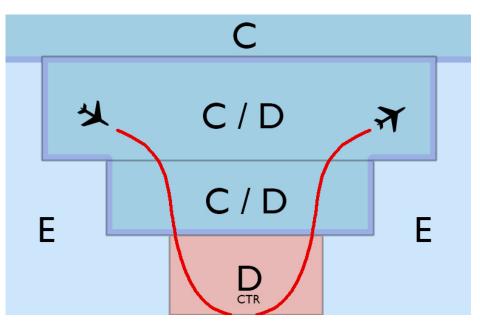

Figure 3: Schematic figure of a stacked airspace structure with one arriving and one departing aircraft

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[390] E.g. the ceiling is less than 1500 ft and the ground visibility is less than 5 km, a VFR flight shall not land or take of at an aerodrome within a control zone, SERA.5005 lit. b).

[391] A schematic overview of the airspace structure in the Federal Republic of Germany: DEUTSCHE FLUGSICHERUNG [2010], *Airspace Structure / Visual Flight Rules in the Federal Repuclic of Germany*, <http://www.dfs.de/dfs_homepage/de/Flugsicherung/Luftraum/luftraumplakat.pdf>.

[392] And the sovereignty over the air within the national borders above the ground will be recognized since the paris convention: v.s. C II., *International Civil Aviation Organization*, p. 37.

Contrary to the image above, on a map a viewer is looking at a two-dimensional figure, the third dimension comes from the indications about the starting height and end height of the zones.[393] That indication is written along the horizontal border of the zone which is pictured in the map. Starting and landing aircrafts have a determined rate of climb and descent rate. This means in effect that 20 km outside of the arrival or departure airport the aircrafts will have designated heights,[394] regardless if starting or landing. Aircrafts that are flying at a much lower heights (in airspace E for example) will not interfere with starting an landing aircrafts at such a distance to the airport. [395] Airspaces can define the route of the flight[396] considerable. A restricted area for example is not allowed to be entered.[397] The flight route must be planned accordingly left, right, over or below the restricted area. Control zones might only be entered with proper permission. When no permission is granted an alternative route must the sought.

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[393] As for the airspaces around Hannover (for a small snippet of an ICAO map with the area around Hannover, Hildesheim and Braunschweig: v.i. Figure 5: VFR flight route at D I 2. Determination of the route on p. 44), the outer blue ring, which is in the south-east corner very close to Hildesheim, defines the airspaces D (FL100 to FL60) and C (FL60 to 4500 ft). The inner blue ring, with the south-east corner being pretty much exactly between Hannover and Hildesheim, redefines the airspace C (FL60 to 2500 ft), airspace D stays the same. The pink area, centering around the airport of Hannover and cutting the city of Hannover in half with the south end, defines airspace D (2500 ft to ground). Such a set up around an airport is not unusual and the visualization can be described as an „*upside-down tiered wedding cake*": HOLANDA [2009], *A History of Aviation Safety,* p. 171.

[394] The rate of decent and rate of climb is varying and depends on the concerned aircraft model.

[395] The closer low-flying aircrafts come to the airport, the more likely an interference will be. For that reason the airspaces C and D are defined as an upside-down tiered wedding cake, while the inner definition of airspace D reaches to ground level, ensuring that no interference will happen.

[396] V.i. D I 2., *Determination of the route*, p. 43.

[397] MENSEN [2010], *Moderne Flugsicherung,* pp. 133 et seq.

2. Determination of the route

In contrast to planning a route from one location to another for use by car, bicycle or foot, which is literally down to earth; a flight route is above the ground and, therefore, three-dimensional.[398] To vividly illustrate an example the following track within the Federal Republic of Germany will be used: From Hildesheim[399] to Braunschweig[400], Braunschweig to Hannover[401] and Hannover back to Hildesheim.
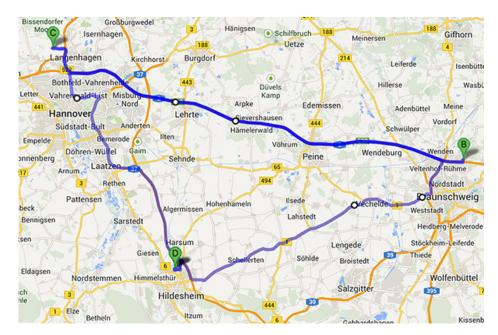

Figure 4: Google Maps street route (Google Inc.)

The shortest distance between two points is a straight line. When these points are on the surface of the earth a straight line is not possible due to the curvature of the earth; the shortest possible path will be a geodesic (supposed that the surface is smooth).[402] Since maps are two-dimensional, they can not depict the true shape of the earth. There are two types of maps that are used today for navigation purposes due to the fact that this types are keeping the defectiveness to a minimum: the mercator projection and the lambert azimuthul equal-area projection.[403]

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[398] As in above ground level. For the sake of the argument ignoring the fact that the ground itself is three-dimensional with different heights above main sea level.

[399] Airfield (EDVM).

[400] Airport (BWE/EDVE).

[401] Airport (HAJ/EDDV).

[402] A geodesic is a curve on the surface: *Weintri/Kopacz* in: WEINTRIT/ NEUMANN [2011], *Methods and Algorithms in Navigation*, p. 128.

[403] TOOLEY/WYATT [2007], *Aircraft Communications and Navigation Systems*, p. 106.

Maps in aviation are differentiated for the according flight rules. A VFR map contains information that is critical to visual terrestrial navigation whereas such information would only be a distraction for pilots flying under IFR. Another important difference is the utilization of fixed airways for IFR flights. Pilots flying VFR may choose a desired route completely on their own.
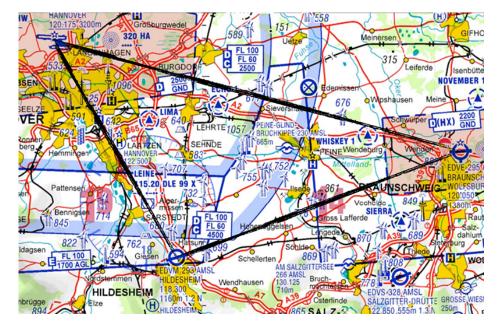

Figure 5: VFR flight route (ICAO map)

The maps have guidelines which are pointing northwards. Through drawing lines between the desired waypoints and the angle from those lines to the northward guidelines (isogenic line), a track[404] from waypoint to waypoint can be determined. The desired flight level is linked to various factors: the minimum height above ground level, the minimum height above obstacles, the airspace zones, the semicircle flight rules, the airways, the weather situation and the technical specifications of the aircraft.

3. Gathering weather information

Gathering and utilizing weather information is an important part of the briefing process. In some weather situations flying is not possible or too risky - if such a weather situation would be ignored the flight may not be conducted safely. The evaluation of a meteorological event is always taking place according to the aircraft model, the specific demonstrated cross wind component of an aircraft is

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[404] Illustrating the course over ground.

one example.[405] Additionally, the weather does not only change in terms of the spatial location, but also in different flight levels on the same spatial location. Therefore, the flight route may be adjusted to benefit from the best possible weather.[406]

4. Calculating track essentials

After basic assumptions about the flight route and the weather conditions have been made, the flight route needs to be calculated in detail. This includes the process of ascending after the start until the desired flight level is reached and descending in the landing process. Significant changes of altitude within the planned route should also be minded, so far they are predictable.

For the simple task of calculating the desired track, the following formula will be calculated:[407]

	True Course
±	Wind Correction Angle
=	True Heading
±	Variation
=	Magnetic Heading
±	Deviation
=	Compass Heading

Determining all the various values can be easy (e.g. the variation can be looked up) to difficult (e.g. calculating the wind correction angel without auxiliaries[408]).

5. Determination of factors linked to the aircraft

When the track is determined, various factors which are based on the specific aircraft model need to be calculated.

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[405] Recordings of crosswind landings with different aircrafts: CARGOSPOTTER [2013], *Crosswind Landings at Düsseldorf - Airbus A330, Airbus A319, Boeing 737-800, Embraer ... (HD)*, <http://www.youtube.com/watch?v=lLmZ5jcQPYE>.

[406] E.g. utilizing the jet stream as tailwind to maximize the speed above ground: AHRENS/JACKSON/JACKSON [2012], *Meteorology Today*, p. 297.

[407] E.g.: ECKERT [2010], *PC-Flugsimulator Training*, p. 127; CLAUSING [1997], *Aviator's Guide to Navigation*, p. 18.

[408] FREY [2012], *Streckenfliegen*, p. 98.

a) Estimated times

Estimated times, like the estimated time of arrival[409], are contingent from weather conditions[410] and the aircraft speeds.

b) Fuel consumption

The fuel consumption of an aircraft is not linear in coherence with the flight time. Some procedures require more fuel than others. The start and climbing to the cruise flight level as well as descending and the landing is burning most fuel.[411] When different parts of the track are predicted to have a significantly different fuel consumption (like ascending and descending), the fuel consumption needs to be calculated separately. The result of the calculation should be an accurate fuel consumption for the intended operation. Since the air speed over ground is very variably,[412] the fuel consumption is declared relating to the time flown and not the distance covered.

c) Weight and balance

Every aircraft has specific operating limits. One of those operating limits is the maximum take of weight[413]. If the declared MTOW is correct and the MTOW is exceeded, the aircraft will not lift from the ground. Furthermore, the distribution of weight must be observed. If there is too much weight in the front the aircraft is top-heavy and if there is too much weight in the back the aircraft is tail-heavy. The arm of lever defines the maximum top-heaviness or tail-heaviness in relation to the center of gravity of the aircraft. It is not allowed to operate an aircraft whose cargo is exceeding one of those limits.[414]

d) Additional information responsibilities

ORO.MLR.115 lit. b) states that „*route-specific notice(s) to airmen*[415] *[...] and aeronautical information services*[416] *[...] briefing documentation, if edited by the operator*" are to be stored for three months. It is established that NOTAMs and AIS briefing documentation are appropriate information to the intended operation

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[409] Hereinafter abbreviated as »**ETA**«.

[410] V.s. D I 3., *Gathering weather information*, p. 44.

[411] For a detailed overview of fuel efficiency of an aircraft it may be referred to VASIGH/TALEGHANI/JENKINS [2012], *Aircraft Finance*, p. 103.

[412] E.g. because of the weather conditions: V.s. D I 4., *Calculating track essentials*, p. 45.

[413] Hereinafter abbreviated as »**MTOW**«.

[414] E.g. stipulated by CAT.POL.MAB.100.

[415] Hereinafter abbreviated as »**NOTAM**«.

[416] Hereinafter abbreviated as »**AIS**«.

and need to be acquired. For CAT the NOTAMs and AIS briefing documentation even need to be carried on board as stipulated by CAT.GEN.MPA.180. However, it is questionable wether the term „*carried*" implies that NOTAMs and AIS briefing documentation must be on a tangible medium.[417] The general details of submitting a flight plan are laid down in SERA.4001, when a flight plan shall be submitted is laid down in SERA.4001 lit. b). The list of necessary contents of the flight plan is to be located in SERA.4005. If a flight plan has been submitted, the flight plan needs to be closed.[418]

6. Submitting a flight plan

Flight plan is defined as „*specified information provided to air traffic services units, relative to an intended flight or portion of a flight of an aircraft*", Article 2 № 79 Commission Implementing Regulation (EU) No 923/2012. A flight plan is to be delivered to an air traffic services reporting office. An „*air traffic services reporting office means a unit established for the purpose of receiving reports concerning air traffic services and flight plans submitted before departure*", Article 2 № 34 Commission Implementing Regulation (EU) No 923/2012.

II. Analogue solutions

The analogue procedure to obtain the necessary information and calculate the intended operation is quite time consuming due to the enormous workload. Additionally, some calculations are very susceptible to errors because the algorithms and formulas that have to be used might be tricky.[419]

A good assistance is the (analogue) flight computer E-6B[420], with which a huge amount of tough calculations can be done by shoving the scales around.

One example of a (in comparison very easy) calculation is the ground speed. The ground speed needs to be calculated in order to have the flight time, which is determining the fuel consumption.[421] A very fundamental step of calculation. The formula for calculating the

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[417] For a detailed analyzation if flight records need to be on a tangible medium and can therefore be „*carried*": V.i. F II 1 c cc), *Tangible or intangible type of record*, p. 60.

[418] V.i. F I., *Booking out of the flight plan*, p. 57.

[419] An overview of the comprehensive calculations done with respect to the operating speeds: FILIPPONE [2012], *Advanced Aircraft Flight Performance*, pp. 203 et seq.

[420] Description in more detail: CROUCHER [2008], *Jar Private Pilot Studies*, pp. 4-11 et seq.

[421] In detail: PHILLIPS [2004], *Mechanics of Flight*, p. 257.

ground speed (GS) is utilizing the true air speed (TAS) and the head wind (HW):

$$GS = TAS \pm HW$$

The headwind is determined by the angle (A) of the wind and the wind speed (WS):

$$HW = \cos(A) * WS$$

III. Digital solutions

1. Automatization of the calculations

Since the necessary calculations do not differ over time it is an obvious step to program the algorithms into a software that automates the calculation process.

Meanwhile there is quite a huge amount of software available that is covering the addressed tasks. One of the many solutions is provided under the name „*fl95.de*"[422].

By the use of this service[423] the planning process of an intended operation is done within a few minutes. A user is able to load aircraft models with pre-defined setups and alter them to suit the actual aircraft that is being used for the operation.[424] The arm of lever, which is different for every aircraft, is one example of such settings. With already loaded aircraft settings the user is only adding information that is unique to every flight: the weight of the persons sitting in the aircraft with their according seat positions, amount of fuel, waypoints, desired flight level, luggage weight and weather data. The complete planning process will be done automatically. If some results state that they are outside of the operating limits, the software will mark these results in red.[425]

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[422] Available online: FL95.DE [2013], *FL95.de: Die kostenlose VFR-Flugplanung*, <http://fl95.de/index.php>.

[423] This service is SaaS and may be additionally classified as „*cloud-computing*", elaboration and reservations: v.s. B II 3., *The unification of information and technology*, p. 10.

[424] Such settings can be saved and loaded again when used the next time.

[425] E.g. not enough fuel for the track, exceeding the MTOW or a too tail-heavy distribution of mass.

Additionally, the software even generates a map with a drawing of the flight route:
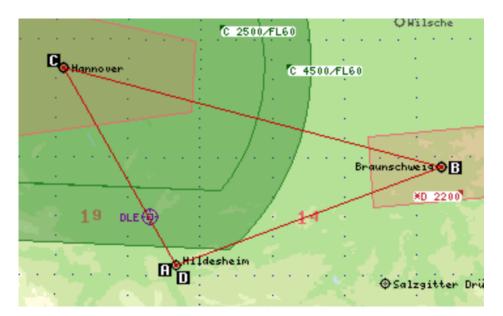

Figure 6: VFR flight route (FL95.de map)

In contrast to the ICAO map,[426] the map provided by the flight planning service of FL95.de offers not that much of information. Since the PIC has to become familiar with all available information, using such a map for navigation purposes is not sufficient.

The question arises, whether or not a pilot is allowed to utilize such a software to what extent. Every single step of a calculation done by hand is vulnerable to human error. However, if the calculation is done by hand the PIC is very familiar with the things he planned. If a PIC is uses software that is doing all the work, the PIC might not fulfill the requirement of being „*familiar*" with the information. However, due to the fact that human error appears often, calculating the data with software and then give the results a doubtful check will be the less fault-prone procedure resulting in the best safety. As to the route planning, the PIC may use software that supports digital ICAO maps. It is questionable, whether the PIC has to make an analogue stroke into is paper-based map.

„*The obligatory stroke of the flight route in the map, if with pencil or electronically, should still be conducted before flying. Just so you can see what is going on at the track, what to really look for, what airspace will be crossed and in what altitude one can perform the flight safely.*"[427] Even if the stroke is done digitally by a software on

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[426] V.s. Figure 5: VFR flight route, D I 2. Determination of the route on p. 44.
[427] Original: „*Der obligatorische Strich fuer die Flugstrecke auf der Luftfahrtkarte,*

a legitimate map, the process of drawing the flight route into the map
and really recognizing the whole track is forcing the PIC to become
more familiar with the path. The chance of noticing surrounding
obstacles and all relevant airspace zones is higher.

2. Gathering information

All information concerning the intended operation needs to be pro-
cured. For instance, weather data is traditionally published as a
meteorological aerodrome report[428] and the terminal aerodrome fore-
cast[429]. The design of a METAR or TAF is designed to make the
information distinct. The layout has no implementations whatso-
ever regarding integrity[430] or authenticity[431]. When it was not ques-
tionable wether or not the concerned aerodrome has issued the in-
formation, this was not a problem. Due to the fact that several
applications are programmed to supply a PIC with weather infor-
mation over unsecured networks, the originator of the data should
be clear. Deutscher Wetterdienst[432] is a provider of weather data in
the Federal Republic of Germany. The product for aviation weather
from the DWD is „*pc_met*”.[433] Also not the default setting, pc_met
is available through a SSL/TLS encrypted connection.[434] The data
that is offered on the site, however, has no provisions to ensure in-
tegrity or authenticity. When information is utilized which was sent
over open networks, the PIC should ensure that efforts were being
made to document the validity of the given data or that the PIC
had no reason to be suspicious about the data quality. As a long
term solution the providers should use digital signatures[435] to ensure
authenticity and integrity.

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ob nun mit Bleistift oder elektronisch, sollte weiterhin vor dem Flug gezo-
gen werden. Nur so kann man wirklich erkennen, was auf der Strecke los
sein wird, worauf man zu achten hat, welche Luftraeume man durchfliegen
wird, und in welcher Flughoehe man den Flug sicher durchführen kann.”: AIR-
CRAFT OWNERS AND PILOTS ASSOCIATION [2012], *Safe Letter: Luftraumverlet-*
zungen, p. 19, <https://aopa.de/entwicklung/upload/PDF/Publikationen/
AOPA-Letter/2012/Letter_05-2012.pdf>.

[428] Hereinafter abbreviated as »METAR«. Description: FREY [2012], *Strecken-*
fliegen, p. 71.

[429] Hereinafter abbreviated as »TAF«. Description: KLUSSMANN/MALIK [2004],
Lexikon der Luftfahrt, p. 270.

[430] V.s. B III 2., *Integrity*, p. 12.

[431] V.s. B III 1., *Authenticity*, p. 12.

[432] Hereinafter abbreviated as »DWD«.

[433] DEUTSCHER WETTERDIENST [2013], *www.flugwetter.de - Der pc_met - Internet*
Service, <http://www.flugwetter.de>.

[434] V.s. B III 3 e bb), *SSL / TLS*, p. 22.

[435] V.s. B III 3 d cc β), *Qualified electronic signatures*, p. 20.

IV. Instant of time

Flight-planning as required by SERA.2010 shall be completed *„[b]efore beginning a flight"*. The availability of information or the facts that lead to a possible information are subject to the point in time in relation to the flight. The weather data should be as accurate as possible. Therefore, not every point in time before a flight is sufficient. If the point in time is too early the weather forecast will be most likely incorrect.

V. Accuracy

Given the discussed waypoints above, this is how the actual track could look like when a scenic flight is the intended operation:

Figure 7: Flight route visualized on Google Maps (Google Inc.)

It is quite difficult to plan scenic flights accordingly. Flight planning software assumes that a PIC would want to fly the direct way in accordance with the best aircraft utilization. But this is not true for scenic flights. Scenic flights are dynamic, passengers may ask to see designated buildings or areas while the flight is progressing. If the PIC would now use a flight planning software just to „*have a stroke in the map*" this solution would not be suitable for SERA.2010. The calculations may be used but need to be adjusted accordingly, like adding more flight time. Otherwise the PIC did not become familiar with all available information and violated the provision of SERA.2010 in bad faith.

E. Flying

The most critical phases while flying are starting and landing. If an incident happens in these stages, the altitude of the aircraft is most likely not high enough to ensure that the PIC has suitable time to react accordingly. Since an aircraft crash is a single and vivid event, it will be remembered easily, leading to the fact that the availability heuristic has many memories of plane crashes, resulting in a base-rate fallacy and therefore a misperception of the risk.[436] It is the duty of the legislator to balance the risk and the benefits accordingly. „*For an aircraft, or aircraft part (airworthiness), is the possession of the necessary requirements for flying in safe conditions, within allowable limits*" compulsory.[437]

I. Portable digital devices

1. Convenience

Portable digital devices, like smartphones or tablets, make flying way more convenient.[438] Checklists can not only be stored on those devices, every already reviewed item can be checked as reviewed through a gesture with the fingertip. Maps and approach charts are constantly available and, given a Global Position System[439] receiver, updated and adjusted in real-time.

2. Habituation evaluation

The habituation to the digital devices may be a concern. In an effect of failure, the convenience is suddenly missing. A huge part of the pilot training is dedicated to handling emergency situations and internalizing the appropriate procedures. An aircraft and the

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[436] KASSIN/FEIN/MARKUS [2013], *Social Psychology*, p. 121.

[437] RAI-ENAC TECHNICAL REGULATIONS cited after: FLORIO [2011], *Airworthiness*, p. 3.

[438] How convenient is depending on the aircraft and the interior of the aircraft. The convenience of a new IFR equipped aircraft with glass-cockpit and user friendly software is already quite high. For example, when dialing in a new frequency on the radio, the pilot may make a mistake and dial in a wrong frequency. Normally, such a mistake will only be discovered when the pilot starts to use the wrong frequency. Two new Garmin radios (GNC 255a nav/com and GTR 255 com) have an extensive database of radio frequencies of the USA and show the respective counterpart to the corresponding dialed in frequency: HIRSCHMANN [2013], *Avionics: Who are you talking to?*, <http://www.aopa.org/News-and-Vide o/All-News/2013/July/1/Avionics-Who-are-you-talking-to.aspx>. This very small change to the product makes it more convenient and the probability of radioing on the wrong frequency is reduced.

[439] Hereinafter abbreviated as »GPS«.

parts inside are tested and evaluated for initial airworthiness and any change needs to fulfill the continuing airworthiness requirements.

3. Challenges

In contrast to traditional analogue gear, digital devices come with different challenges that need to be addressed accordingly.

One challenge is a black-box phenomenon: Due to the very strict software copyright protection in the EU[440], which has no provision like the fair-use clause in the USA,[441] a license from the rightholder is needed to analyze the software. Since the rightholder is interested in maintaining as much legal positions as possible, granting a license to reverse engineer the software to a user will not be in the interest of the rightholder. Even organizations that are entitled to audit, check and approve safety-critical goods do not have an exemption in Directive 2009/24/EC and would therefore need a license or are infringing copyright. In addition, newer operating systems for mobile devices have „*kill switches*", enabling the manufacturer inter alia to delete applications remotely without the consent of the user.[442] An interesting question is, how often a manufacturer supposedly „*throw the dreaded kill switch on apps?*"[443]

A second challenge might be the battery runtime. Due to heavy use of real-time location data and bad cell reception[444] the battery drains faster than in a normal operating environment. If no charger is present and there is no power left, all things stored become unaccessible and the device will be completely useless.

A third challenge might be the operating standards. Digital devices are very sensitive to water and mostly designed to operate in non-condensing environments.[445] Furthermore, they can overheat. Putting a digital device on the storage place behind the front window in summer in Germany, can already be enough to trigger the automatic cut out. The other end of the temperature scale is also likely to cause the device to malfunction. For example the Apple

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[440] V.s. B III 4 c), *Copyright issues*, p. 26.

[441] For a comparison between the fair use clause and the barriers to copyright in the German copyright law it may be referred to: FÖRSTER [2008], *Fair Use*.

[442] MORLEY/PARKE [2013], *Understanding Computers*, p. 596.

[443] *Thierer* in: SZOKA/MARCUS [2010], *The Next Digital Decade*, p. 154.

[444] Which brings the device to try to log into a cell constantly.

[445] Water could shorten the circuits, since the devices are produced with very stuffed boards, a shortened circuit is also highly likely if the devices comes into contact with water. If a short circuits happens, even wires 1 1/2 inches away might be affected: NATIONAL TRANSPORTATION SAFETY BOARD [2000], *Aircraft Incident Report*, p. 286.

iPad has environmental requirements of an operating ambient temperature from 0° to 35° C, a nonoperating temperature from -20° to 45° C and the relative humidity must be between 5% to 95% non-condensing.[446]

4. Possible installation of portable devices

Whereas the initial airworthiness of an aircraft[447] is subject to Annex I of Commission Regulation (EU) No 748/2012, the regulations for continuing airworthiness can be found in Annexes I to IV of Commission Regulation (EC) No 2042/2003.

M.A.501[448] stipulates the basic requirements of installing components in an aircraft.[449] It deals with the „*installation*" of components (M.A.501 lit. b))[450] and the fitting of parts (M.A.501 lit. c))[451].

Speaking of an installation of a device when this device is not fixed or at least clamped in the aircraft, might sound abstruse. However, this could suite the ratio legis more than screwing a few bolts into the plastic. The sense of the regulation is to maintain a high safety level, ensuring that no third party is implementing untested or unreliable components in the aircraft. Given that a digital device is not screwed on tightly does not hide the fact that the PIC brought the device on board to use it while flying. If the scope of M.A.501 would be seen as so narrow, that at least some permanent connection with the aircraft must exist, this would lead to a huge regulatory gap. Installing new avionics under avoidance of the regulations concerning the continuation of airworthiness could be done easily by not establishing a permanent connection with the aircraft.

Hence a portable device may be seen as an installment, disregarding that there is no physical connection.

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[446] APPLE [2013], *iPad - View all the technical specifications*, <http://www.apple.com/ipad/specs/>.

[447] To be assumed here.

[448] Annex I of Commission Regulation (EC) No 2042/2003.

[449] „*No component may be fitted unless it is in a satisfactory condition, has been appropriately released to service on an EASA Form 1 or equivalent and is marked in accordance with Part 21 Subpart Q, unless otherwise specified in Annex (Part-21) to Regulation (EC) No 1702/2003, Annex II (Part-145) or Subpart F, Section A of Annex I to this Regulation*".

[450] „*Prior to installation of a component on an aircraft the person or approved maintenance organisation shall ensure that the particular component is eligible to be fitted when different modification and/or airworthiness directive configurations may be applicable.*"

[451] „*Standard parts shall only be fitted to an aircraft or a component when the maintenance data specifies the particular standard part. Standard parts shall only be fitted when accompanied by evidence of conformity traceable to the applicable standard.*"

II. Appraisal of available information

The most common installations and protocols which are used for aviation[452] are sending the data without any measures to ensure authenticity[453] or integrity[454].

The Automatic Dependent Surveillance Broadcast[455], which is used for broadcasting the position of the aircraft to other aircrafts and the FIS, also uses completely exposed protocols. Since the ADS-B is sending on 1090 MHz for scheduled air services and on 987 MHz for general aviation, listening on that frequency can be done with a customary DVB-T[456] stick.[457]

III. Safety implications

1. Man-in-the-middle attack over the radio

A man in the middle attack performed over the radio would not occur unnoticed by the FIS. Therefore, this attack vector is not safety critical. When the FABs[458] defragmented the airspace zones, the frequency changes will be also less.

2. Jamming signals

Jamming a GPS signal for instance is very easy due to the fact that the satellites are far away. However, if the GPS signal is blocked, this will not happen unnoticed and other measures will be stricken.[459]

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[452] Radio, Non-Directional Beacon, Automatic Direction Finder, VHF Omnidirectional Radio Range, Distance Measurement Equipment, Instrument Landing System as well as the Global Positioning System.

[453] V.s. B III 1., *Authenticity*, p. 12.

[454] V.s. B III 2., *Integrity*, p. 12.

[455] Hereinafter abbreviated as »ADS-B«.

[456] Digital Video Broadcast - Terrestrial.

[457] SPRUT [2013], *ADS-B Decoder and Software with PIC18F2550*, <http://www.sprut.de/electronic/pic/projekte/adsb/adsb_en.html>.

[458] V.s. C I 7., *Functional airspace blocks*, p. 35.

[459] A truck driver who wanted not to be surveilled by his employer put a GPS jammer in operation. The result was a disruption of the Newark airport system, he was fined \$ 32.000: STRUNSKY [2013], *N.J. man fined \$32K for illegal GPS device that disrupted Newark airport system*, <http://www.nj.com/news/index.ssf/2013/08/man_fined_32000_for_blocking_newark_airport_tracking_system.html>.

IT in general aviation: Pen and Paper vs. Bits and Bytes

Dipl.-Jur. Sebastian Höhne   E III 3. Spoofing signals

3. Spoofing signals

Spoofing signals in contrast to just jamming signals can be very dangerous.[460] Spoofing unsecured signals, which are not even secured by security-through-obscurity[461] approaches, can be done by everyone with a little interest.[462]

When an aircraft is equipped with a Traffic Alert and Collision Avoidance System[463] and it is is linked to a data source which offers no provisions to ensure integrity and authenticity, a fake plane can very easily influence the flight path of an actual plane, due to the fact that the TCAS will give the pilot a Resolution Advisory[464] to dodge the fake plane.[465] If the TCAS is connected to the auto pilot,[466] a remote control is possible with this attack vector. The extent of this attack could not be established.

4. Infiltration of the Flight Management System

If a plane is equipped with a Flight Management System[467] the plane is totally controlled by computers. Even the controls are just communicating with the FMS.[468] Hugo Teso has implemented a FMS on a x86 environment and reverse engineered[469] the system in order to find security holes. He was successful by finding an attack vector which allowed him to gain, completely remotely, root on the FMS.[470] Showing off, he programmed the Android application „*PlaneSploit*" as the remote control.[471]

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[460] A graphical virtual visualization of spoofed ADS-B signals: RENDERMAN HAINES [2012], *Spoofing ADS-B*, <http://www.youtube.com/watch?v=NSLqRXyxiBo>.

[461] V.s. B III 3 c dd), *Security through obscurity*, p. 16.

[462] For a deeper insight watch: Idem [2012], *DEFCON 20: Hacker + Airplanes = No Good Can Come Of This*, <http://www.youtube.com/watch?v=CXv1j3GbgLk>.

[463] Hereinafter abbreviated as »TCAS«.

[464] Hereinafter abbreviated as »RA«.

[465] In-flight recording of a TCAS RA: YOURCPTSPEAKING [2011], *Citation X - TCAS Resolution Advisory*, <http://www.youtube.com/watch?v=gDOENQbxRR4>.

[466] AIRBUS [2009], *EASA certifies new Autopilot/Flight Director TCAS mode for A380*, <http://www.airbus.com/presscentre/pressreleases/press-release-detail/detail/easa-certifies-new-autopilotflight-director-tcas-mode-for-a380/>.

[467] Hereinafter abbreviated as »FMS«.

[468] Depending on the aircraft model.

[469] In the EU that would probably infringing copyright: v.s. **??**, **??**, p. **??**.

[470] His presentation of the topic: TESO [2013], *#HITB2013AMS D1T1 Hugo Teso - Aircraft Hacking: Practical Aero Series*, <http://www.youtube.com/watch?v=wk1jIKQvMx8>.

[471] Which was widely recognized by the press, e.g.: CLARK [2013], *Security consultant hijacks plane's navigation system with Android app*, <http://www.wired.co.uk/news/archive/2013-04/11/android-plane-hijack>.

F. Debriefing

After a conducted flight a debriefing ensures that some learning process is secured,[472] provided that the term debriefing is understood as talking about what happened and analyzing the occurred situations.[473] The term briefing as in de-briefing or post-flight briefing exists in Commission Regulation (EU) No 1178/2011 exactly two times: FCL 915.SFI lit. c) (2) (ii)[474] and FCL.935 lit. a) (2)[475] Annex I Commission Regulation (EU) No 1178/2011. The debriefing process as a learning process is not defined in any EASA rules.[476] In a broad understanding debriefing does not only include measures to assure the learning process, but also everything that needs to be completed after a flight. Aside from technical aspects like securing the aircraft at its parking destination, the PIC has to book out of the flight plan[477] and to finish the documentation.

I. Booking out of the flight plan

If a flight plan was submitted,[478] booking out of the flight plan is mandatory: *„An arrival report shall be made in person, by radiotelephony, via data link or by other means as prescribed by the competent authority at the earliest possible moment after landing, to the appropriate air traffic services unit at the arrival aerodrome, by any flight for which a flight plan has been submitted covering the entire flight or the remaining portion of a flight to the destination aerodrome"*, SERA.4020 lit. a).[479] *„[...] [F]ailure to comply with the provisions of SERA.4020 may cause serious disruption in the air traffic services and incur great expenses in carrying out unnecessary search and rescue operations"*, GM1 SERA.4020[480]. The details of the provided alerting service are laid down in SERA.10001 et seq.[481]

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[472] *Wilson/Guthrie/Salas/Howse* in: Wise/Hopkin/Garland [2010], *Handbook of Aviation Human Factors*, p. 9-16.

[473] Grau [2006], *Kurzinterventionen nach traumatischen Ereignissen*, p. 3.

[474] Dealing with the prerequisites of a synthetic flight instructors applicant.

[475] Dealing with the assessment of competence.

[476] V.s. C I 6., *European Aviation Safety Agency*, p. 32.

[477] If applicable.

[478] V.s. D I 6., *Submitting a flight plan*, p. 47.

[479] Exemption: *„Submission of an arrival report is not required after landing on an aerodrome where air traffic services are provided on condition that radio communication or visual signals indicate that the landing has been observed"*, SERA.4020 lit. a) (1).

[480] Annex to ED Decision 2013/013/R.

[481] An overview of the three alert phases (INCERFA, ALERFA and DETRESFA): Flühr [2010], *Avionik und Flugsicherungstechnik*, p. 14.

II. Documentation

1. Concerning the Pilot In Command

„The pilot shall keep a reliable record of the details of all flights flown in a form and manner established by the competent authority", FCL.050 Annex I Commission Regulation (EU) No 1178/2011.
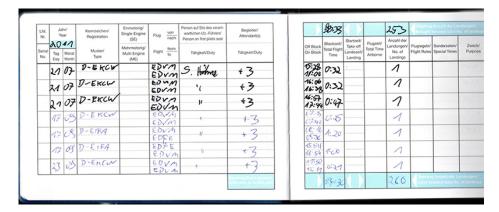

Figure 8: Flying Logbook (Luftfahrtverlag Friedrich Schiffmann)

a) Competent authority

„For the purpose of this Part, the competent authority shall be an authority designated by the Member State to whom a person applies for the issue of pilot licences or associated ratings or certificates", FCL.001 Annex I Commission Regulation (EU) No 1178/2011.

For example in Germany the § 120 I LuftPersV stipulates that non-commercial pilots must maintain a logbook in which *„all flights [..] stating the work performed and the type of aircraft by date, type of flight, plate of the aircraft, if this is mandatory, aerodrome of departure/arrival as well as time of departure and arrival (times in block time in Coordinated Universal Time (UTC)), total duration of the flight, total flight time must be specified."*[482]

The FCL grants the national aviation authorities a very wide set of possibilities.

b) Details

How much detail is necessary for the flight records is not established in FCL.050. Minimum requirements in AMC.1 FCL.050 are inter alia the personal details of the pilot[483] as well as for each flight the

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[482] Original: *„[...] in dem alle Flüge [..] unter Angabe der ausgeübten Tätigkeit und des Luftfahrzeugmusters nach Datum, Art des Fluges, Kennzeichen des Luftfahrzeuges, wenn dieses vorgeschrieben ist, Start-/Landeflugplatz sowie Abflug- und Ankunftszeit (Zeiten in Blockzeit in koordinierter Weltzeit (UTC)), Gesamtdauer des Fluges, Gesamtflugzeit anzugeben sind."*

[483] AMC.1 FCL.050 lit. a) (1).

„name(s) of PIC, date of flight; place and time of departure and arrival; type; including make, model and variant, and registration of the aircraft; indication if the aircraft is SE or ME, if applicable; total time of flight [and] accumulated total time of flight."[484]

c) Reliable record

aa) Definition

What a reliable record is or consists of is not defined in the Commission Regulation (EU) No 1178/2011 or its annexes. Given a possible uniformity of EU law,[485] other directives or regulations may be looked up for a definition. Unfortunately, there is no definition of a reliable record within the EU law and moreover the term reliable record is being used very little.[486]

bb) Delimitation from a durable medium

To shape the content of the term a little bit and to delimit it from similar provisions, a brief comparison with the concept of a *„durable medium"* as used in Art. 5 № 1 Directive 97/7/EC may be suitable. Although a very important term, the definition of a durable medium was not presented in the Directive 97/7/EC itself.

Art. 2 (10) Directive 2011/83/EU, which is repealing Directive 97/7/EC, defines a durable medium as: *„[...] any instrument which enables the consumer or the trader to store information addressed personally to him in a way accessible for future reference for a period of time adequate for the purposes of the information and which allows the unchanged reproduction of the information stored.*[487]*"*

Recital № 23 Directive 2011/83/EU elaborates further that *„[d]urable media should enable the consumer to store the information for as long as it is necessary for him to protect his interests stemming from his relationship with the trader. Such media should*

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[484] AMC.1 FCL.050 lit. a) (2).

[485] CHALMERS/DAVIES/MONTI [2010], *European Union Law*, pp. 160 et seq.

[486] In № 3.3 GREEN PAPER Marine Knowledge 2020 from seabed mapping to ocean forecasting; № 42 lit. b) Special Report No 3/2004 on recovery of irregular payments under the Common Agricultural Policy together with the Commission's replies; № 59 of Special Report No 10/2012 *„The effectiveness of staff development in the European Commission"* as well as two times in № 15 Commission staff working document - Accompanying document to the Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions - Preparing the next steps in border management in the European Union - Impact assessment (COM(2008) 69 final) (SEC(2008) 154).

[487] Other definitions can be found in Art. 2 lit. f) Directive 2002/65/EC and Art. 2 № 12 Directive 2002/92/EC, further elaborated in the ECJ Case C-49/11.

include in particular paper, USB sticks, CD-ROMs, DVDs, memory cards or the hard disks of computers as well as e-mails." This means firstly that the medium is technology neutral and secondly, that the durability is a requirement only for the medium and not the data that is stored on it. For instance, data on an USB stick or on an e-mail server may be altered. Authenticity[488] or integrity[489] of the data is not required.

cc) Tangible or intangible type of record

There is no specification of a possible mandatory record type of the flown flight expressis verbis. As elaborated, the durable medium is technology neutral as long as the laid down requirements of durability are met. Being technology neutral could also be the case for a reliable record of flown flights, allowing as well pen & paper and bits & bytes solutions. FCL.045 lit. c) stipulates that „*[a] pilot or a student pilot shall without undue delay present his/her flight time record for inspection upon request by an authorised representative of a competent authority,*" and FCL.045 is given the headline „*Obligation to carry and present documents*". It is only possible to carry tangible things - therefore a digital version of the records could be excluded. However, FCL.045 lit. a), lit. b) and lit. d) states which documents a pilot has to „*carry*" in what situations. Carrying the flight records is not a requirement of FCL.045 lit. c), they only must be presented without undue delay. And even if carrying would be a condition, a traditional logbook can be carried. However, a logbook is not a flight record. The logbook contains the flight record. Data should not be confused with the data carrier.[490] Whereas the intangible flight record is perpetuated in a logbook, an intangible digital flight record has to be stored on a physical medium[491].

Furthermore, as laid down by Art. 5 № 2 Directive 1993/93/EC, „*Member States shall ensure that an electronic signature is not denied legal effectiveness and admissibility as evidence in legal proceedings solely on the grounds that it is [..] in electronic form*". Since the flight records do not need to be signed,[492] as an argumentum a maiori ad minus[493] it can be stated that denying a legal effect for an

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[488] V.s. B III 1., *Authenticity*, p. 12.

[489] V.s. B III 2., *Integrity*, p. 12.

[490] KLEIN [2000], *Case Studies of Security Problems and Their Solutions*, p. 18.

[491] DIEDEREN [2010], *Global resource depletion*, p. 75.

[492] V.i. F II 1 c dd), *Ensuring reliability*, p. 61.

[493] BEAUCAMP/TREDER [2011], *Methoden und Technik der Rechtsanwendung*, p. 83.

electronic document without the higher protection of a signature is also prohibited.[494] Therefore, any type of record, imputing that the record is reliable, is in accordance with FCL.050.

dd) Ensuring reliability

α) Reliability of the medium

The reliability of the demanded records may be interpreted as reliability with respect to the medium on which the record is stored on or with respect to the data that the records is presenting. In case of the latter, the data must contain provisions to ensure at least integrity, if not even authenticity. The wording is not „*reliable medium*" which would point the reliability directly to the medium. The usual method of keeping the flight records is to have a paper-based logbook that contains handwritten entries.[495] In this case the integrity of the entries are ensured by the perpetuation with the medium and thus the impossibility to alter an entry unnoticed. Even removing pages from the logbook is easily noticeable. The only way to alter one or more entries is to start a new logbook and rewrite all entries to the new medium. That approach will, however, be problematic when the logbook contains signatures by third persons.[496] But signatures, which would constitute a written form,[497] are not required for the records. Furthermore, the records may be filled in by any person. The documentation process is not bound to the PIC in person. It also can not be established if an entry is true or false. Furthermore, this view focusses more on the medium than on long-term reliability of the records itself.

β) Using a third party Content Management System

In modern content management systems[498] for chartering aircrafts[499] not only the flying time of the aircraft will be entered, but also the flight record of the concerning pilot[500]. It is questionable whether such a solution is fulfilling the requirement of reliability for the flight

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[494] Although the strict approval of contracts concluded by electronic means was introduced later in Section 3 of Directive 2000/31/EC.

[495] V.s. Figure 8: Flying Logbook, F II 1. Concerning the Pilot In Command on p. 58.

[496] E.g. for type-ratings or instruction flights.

[497] In the sense of § 126 I BGB.

[498] Hereinafter abbreviated as »CMS«.

[499] Like Aircraft Info Desk.

[500] Mostly for billing purposes, however, with Aircraft Info Desk a pilot may use the software for the purpose of storing his flight records too.

records from the beginning or if some additional measures can be taken to ensure the fulfillment. A CMS typically stores the entered data on a server in a database on the hard disk.[501] Provided that the front-end qualifies as software such a setup can be called SaaS, if the server location is unknown it would be a cloud solution.[502] A hard disk is a medium that is re-writable, thus any entry can be altered. Reliability in terms of durability is given.[503] As for the reliability in terms of the records itself a reliability is not given, if there is no way to detect an alteration.[504] Given that a QES is even able to substitute a hand-written signature,[505] this method is to be seen as reliable. Since a hand-written signature is not a mandatory component, it is arguable whether requiring the same level of protection for the digital version as for the non-digital version shall be enough. Transposing the non-alteration component to the digital world, this can be achieved with an advanced electronic signature or storing the data on a write once read many medium[506] like a CD-ROM. Given that possibility, the question of usability is at hand. Using a CMS for storing the data and burning a new CD-ROM for every new record may be suitable to fulfill the reliability but is not practical at all. Advanced electronic signatures may be usable in a CMS, but the private key holder could still alter the data at any time.[507] In addition, the administration of the CMS is not within the sphere of the concerned pilot. If something like a data loss happens,[508] the person who is to be held liable is the pilot and not the admin of the CMS. Even if the pilot would shift the responsibility to the administrator of the CMS by contract, that contract would only be effective inter partes[509] and not be able to shift the responsibility from FCL.050. The competent authority would still have to hold the pilot accountable, whereas the pilot could only afterwards sue the administrator of the CMS for damages which resulted from that situation.

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[501] SMITH [2013], *Elementary Information Security*, pp. 746 et seq.

[502] V.s. B II 3., *The unification of information and technology*, p. 10.

[503] V.s. F II 1 c cc), *Tangible or intangible type of record*, p. 60.

[504] E.g. conducted by the provider.

[505] V.s. B III 3 d cc β), *Qualified electronic signatures*, p. 20.

[506] Hereinafter abbreviated as »WORM«.

[507] V.s. B III 3 b), *Asymmetric cryptography*, p. 13.

[508] The risk to data loss can be reduced by making backups, however, the risk is never zero. When a data loss occurred at Hotmail (luckily only temporarily), there were 17.355 accounts affected: BURKE, *Data loss hits Hotmail users*, <http://www.cryptzone.com/news/article.aspx?category=Email-security&title=Data-loss-hits-Hotmail-users&id=800321824>.

[509] PETERSEN [2009], *Examens-Repetitorium Allgemeines Schuldrecht*, p. 1.

γ) Timestamping digital records

To ensure that a specific record was created at a specific time and was not altered since, creating a timestamp can be a solution. If a timestamp is added to a digital record, that timestamp can as well as the record be altered easily when a WORM medium is not used. Therefore, the requirement of the integrity[510] of the records must be higher when a write many read many[511]-medium like a hard disk is used. To proof that a certain set of data existed on (or before) a certain point in time several methods may be used. One very obvious method is going to the notary and let the notary validate the existence. Since notaries most likely only validate data perpetuated on paper this would be not only very inconvenient but also conclude a media disruption. Another method is a trusted timestamping service, which may also be called digital notary.[512] This approach would involve a TTP[513] and the trustworthiness of this method is relying on the trustworthiness of the TTP. De-mail providers[514] may also serve as a TTP for signing the flight records, though the usability will still suffer if the pilot would have to send a de-mail to ensure the liability of the records. The pilot could timestamp the record personally, using a QES for example. Or with an advanced signature derived from another trusted CA. Such a PKI could ideally be set up by the competent authority. That way it is ensured that the flight records that are being stored on a WMRM medium can not be altered unnoticed without the approval of the key holder. It is in the hand of the aviation CMS administrators to implement such possibilities.[515]

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[510] V.s. B III 2., *Integrity*, p. 12.

[511] Hereinafter abbreviated as »WMRM«.

[512] GABILLON/BYUN [2002], *Trusted Information*, p. 139 (pp. 139 et seq).

[513] V.s. B III 3 d cc), *Certificate authorities*, p. 18.

[514] De-mail is like a quality seal ensuring that the providers and the software for the de-mail service meet certain requirements to ensure a secure and trustworthy communication. However, De-mail is not supporting end-to-end encryption and the provider could bug into all e-mail communication through this service. Furthermore it is advertised as „*legally binding*" but it does not support QES. Therefore it is in terms of the Directive 1999/93/EC as legally binding as any electronic signature, like in a normal e-mail. In more depth: CHAOS COMPUTER CLUB [2011], *Sichere und vertrauenswürdige elektronische Kommunikation via De-Mail*, <http://www.ccc.de/system/uploads/64/original/CCC-de-mail-2011.pdf>.

[515] At best with an open design (v.s. B III 3 c cc), *Open design*, p. 15), in accordance to Kerckhoffs' principle (v.s. B III 3 c bb), *Kerckhoffs' principle*, p. 15) as well as in consultation with the competent authority and ideally EASA.

δ) Opinion of the European Aviation Safety Agency

The EASA states regarding the format of the record of FCL.050 in AMC1 FCL.050 lit. c)[516] in (1) that „*details of flights flown under commercial air transport may be recorded in a computerised format maintained by the operator. In this case an operator should make the records of all flights operated by the pilot, including differences and familiarisation training, available upon request to the flight crew member concerned*" and in (ii) that „*for other types of flight, the pilot should record the details of the flights flown in the following logbook format. For sailplanes and balloons, a suitable format should be used that contains the relevant items mentioned in (a) and additional information specific to the type of operation*". Additionally, „*[a]ll entries in the logbook should be made in ink or indelible pencil*", AMC1 FCL.050 lit. e).

This viewpoint is not convincing. Regarding the concerned safety level,[517] the distinction between CAT and all other types of flight happens without need when only the documentation is concerned. The allowance for operators to use digital means results in an easier and a much more convenient workflow of the operator. Since AMC1 FCL.050 lit. c) does not add any further measures to ensure the reliability of the records when a computerized format is used, as a result this is to be seen as an exemption to the reliability of the records that is postulated by FCL.050 when the records are stored on a WMRM medium.

d) All flights flown

aa) Wording

The mandatory requirement of the FCL is that the pilot needs to keep the reliable records „*of all flights flown*". Given the wording, that would lead to the situation that a pilot could never throw a logbook away, even if it is more than 50 years old.[518] Additionally, AMC1.FCL.050 lit. d) elaborates that „*FCL.050 requires holders of a pilot licence to record details of all flights flown. This logbook enables pilot licence holders to record flying experience in a manner which will facilitate this process while providing a permanent record*

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[516] AMC1 FCL is in Annex to ED Decision 2011/016/R.

[517] V.s. B I 4., *General aviation safety level*, p. 7.

[518] If a person would not extend the pilot license for any reason, the rule would no longer apply due to the fact that the person would not qualify as a pilot anymore.

of the licence holders flying." Contrary to that regulation, in Germany the logbook of a private pilot „*must be kept for two years, calculated from the day of the last entry.*"[519], § 120 LuftPersV.

bb) Impact of data protection legislation

It is questionable, whether or not the requirement to store records of all flights of the FCL is compatible with other EU law. In concreto may the regulation interfere with the protection of personal data as guaranteed by Art. 16 (1) TFEU, the concrete embodiment will take place by the ordinary legislative procedure according to Art. 16 (2) TFEU. Thus, the Directive 1995/46/EC is the implementation of the requirements of Art. 16 TFEU, whereas factually[520] and chronologically[521] the Art. 16 TFEU is based on the scope of Directive 1995/46/EC. Flight records are personal data as defined by Art. 2 lit. a) Directive 1995/46/EC. The „*Directive shall apply to the processing of personal data wholly or partly by automatic means, and to the processing otherwise than by automatic means of personal data which form part of a filing system or are intended to form part of a filing system*", Art. 3 № 1 Directive 1995/46/EC. Therefore even a paper-based logbook will fall under the scope of the directive as a filing system. The household exemption for „*natural person in the course of a purely personal or household activity*"[522] does not apply for the following reason: the pilot may be the processor of the personal data[523] but the purposes and means of the storing process are set by the competent authority which is therefore to be classified as the controller[524]. One of the requirements of the Directive 1995/46/EC is fair and lawful processing,[525] including the principles of data reduction and data economy.[526] Those principles of data reduction and data economy are always to be seen in conjunction with the mandatory purpose of processing personal data.[527]

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[519] Original: „*Das Flug-, Fahrten- oder Sprungbuch ist zwei Jahre, gerechnet vom Tag der letzten Eintragung, aufzubewahren*"

[520] FRENZ [2009], *Handbuch Europarecht Bd. 4*, p. 421.

[521] The Treaty of Lisbon entered into force on the 1st of December 2009, the Directive 95/46/EC on the 24th of October 1995 and had to be implemented within three years by the Member States.

[522] Art. 3 № 2 Directive 1995/46/EC.

[523] Art. 2 lit. e) Directive 1995/46/EC.

[524] Art. 2 lit. d) Directive 1995/46/EC.

[525] Art. 6 № 1 lit. a) Directive 1995/46/EC.

[526] Although not expressis verbis in the Directive, the joint understanding of the principles will lead to that requirement: BYGRAVE [2002], *Data Protection Law*, pp. 341 et seq.

[527] Art. 6 № 1 lit. b) Directive 1995/46/EC.

cc) Purpose and necessity

Flight records within the meanings of the FCL are kept for the purposes of recency, revalidation and renewal of the license or to proof experience. The difference between recency[528] and revalidation[529] is that licenses to which class ratings may be added are being revalidated whereas licenses without this possibility only have recency requirements. Recency requirements that affect the whole license are to be divided further from recency requirements that do not affect the license itself but some executions of the rights granted by the license.[530] Other provisions that may be respective for processing flight records will also be addressed briefly.

α) Recency

Recency requirements are to be found in FCL.140.A,[531] FCL.140.H,[532] FCL.140.S,[533] FCL.140.B,[534] FCL.230.S[535] and FCL.230.B[536]. All of these rules have the same core principle:[537] If the recency requirements are not met, a proficiency check with an examiner in the appropriate class must be passed. Alternatively, the additional premises from the recency requirements must be performed under the supervision of a qualified supervisor. Therefore, any flight record, from a flight that happened over two years ago, is not suitable for the purpose of proving the recency requirements.

β) Revalidation

„*Revalidation (of, e.g. a rating or certificate) means the administrative action taken within the period of validity of a rating or certificate which allows the holder to continue to exercise the privileges of a rating or certificate for a further specified period consequent upon the fulfilment of specified requirements*", FCL.010. For example the concerned period for a revalidation of a single-pilot single-engine aeroplane class rating according to FCL.740.A lit. b) (1) is 3 months

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[528] V.i. F II 1 d cc α), *Recency*, p. 66.
[529] V.i. F II 1 d cc β), *Revalidation*, p. 66.
[530] V.i. F II 1 d cc δ), *Proof of experience*, p. 68.
[531] Recency required within the last 24 months, FCL.140.A. lit. a).
[532] Recency required within the last 12 months, FCL.140.H lit. a).
[533] Recency required within the last 24 months, FCL.140.S lit. a) and lit. b).
[534] Recency required within the last 24 months, FCL.140.B lit. a).
[535] FCL.230.S is incorporating the requirements from FCL.140.S.
[536] Recency required within the last 24 months, FCL.230.B lit. a).
[537] Except FCL.230.S.

with a proficiency check[538] or 12 months with a training flight[539]. Given that „*[t]he period of validity of class and type ratings shall be 1 year, except for single-pilot single-engine class ratings, for which the period of validity shall be 2 years [...]*",[540] the maximum period that may be considered for a revalidation of a license is two years. Therefore any flight record from a flight older than two years is not suitable for the purpose of revalidation.

γ) Renewal

Renewal is defined in FCL.010 as „*the administrative action taken after a rating or certificate has lapsed for the purpose of renewing the privileges of the rating or certificate for a further specified period consequent upon the fulfilment of specified requirements.*" The requirement of a renewal in contrast to a revalidation is the lapse of the license. A license will lapse, when the conditions for a revalidation are not fulfilled. Therefore, any flight records that are not stored for the purpose of getting a license renewed are not necessary. The renewal of a license is in addition not bound to past flight experience but to present experience. For example FCL.740.A states that „*[a]pplicants who fail to achieve a pass in all sections of a proficiency check before the expiry date of a class or type rating shall not exercise the privileges of that rating until a pass in the proficiency check has been achieved.*" The proficiency check „*means the demonstration of skill to revalidate or renew ratings, and including such oral examination as may be required*", FCL.010. This results in the fact that when an applicant had a license or rating that lapsed, the previous flight time does not matter.[541] Storing flight records is not suitable for the purpose of renewal, if the stored flight records are not for the renewal itself.[542]

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[538] „*[...] within the 3 months preceding the expiry date of the rating, pass a proficiency check in the relevant class in accordance with Appendix 9 to this Part with an examiner*", FCL.740.A lit. b) (1) (i).

[539] „*[...] within the 12 months preceding the expiry date of the rating, complete 12 hours of flight time in the relevant class, including 6 hours as PIC, 12 take-offs and 12 landings, and a training flight of at least 1 hour with a flight instructor (FI) or a class rating instructor (CRI). Applicants shall be exempted from this flight if they have passed a class or type rating proficiency check or skill test in any other class or type of aeroplane*", FCL.740.A lit. b) (1) (ii).

[540] FCL.740.

[541] In practical experience the previous flight experience matters of course, but not to the legal requirements wether or not if an applicant is entitled for the proficiency check.

[542] E.g. for refresher training at an ATO: FCL.740 lit. b) (1).

δ) **Proof of experience**

αα) **Experience for privileges from an existing license**

The mandatory recent experience as laid down by FCL.060 for commercial air transport or carrying passengers is linked to certain requirements within the last 90 days.[543] Storing records longer than the given period will have no effect for a proof of recent experience.

ββ) **Experience to obtain new privileges**

Prior experience may be acknowledged for obtaining new privileges more conveniently or it may be a prerequisite to start the process of extending privileges in the first place. In the first case, an applicant is able to choose wether or not to credit the previous experience. There is no obligation to keep flight records for this purpose. For the second, keeping the flight records is mandatory. An example is the rating for a single pilot aeroplane which is classified as a high performance aeroplane: „*before starting flight training, an applicant for a first class or type rating for a single-pilot aeroplane classified as a high performance aeroplane shall have at least 200 hours of total flying experience, of which 70 hours as PIC on aeroplanes [...]*”, FCL.720.A lit. b) (1). The experience is not bound to the experience as a whole, but more to a minimum requirement that has to be fulfilled. Experience exceeding this minimum requirement will not be rewarded. As a result, only the last recent flight records which are required for this process are necessary.

ε) **Ensuring reliability**

The flight records may be stored for reliability purposes.

αα) **Flight book**

If a non-computerized method of recording is implemented, integrity of the entries must be guaranteed.[544] The EASA opinion is that „*[a]ll entries in the logbook should be made in ink or indelible pencil*”, AMC1.FCL.050. The unchangeability of the flight records however do not come from the use of ink or indelible pencil. The unchangeability results of adding a permanent single entry to other permanent entries in such a way that they are inextricably linked.[545] If a flight

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[543] 180 days for balloons, FCL.060 lit. a) (1). And for commercial air transport the 90 days may be extended to 120 days according to FCL.060 lit. c) (1).

[544] V.s. F II 1 c cc), *Tangible or intangible type of record*, p. 60.

[545] The linkage of the entries comes from the perpetuation of the entries with other entries in the physical flight book as a connected document.

book would not be a book but one independent page for each entry, the records would not be reliable anymore because they could easily be exchanged and therefore altered. It makes sense to store the records, regardless of age or additional recent experience, at least until a new flight book has to be started. The German implementation[546] adds a minimum storage period of two years to that point, which ensures that possible recency, revalidation or proofs of experience are covered.

ββ) Computerized recording

When the flight records are computerized, the reliability does not rely on a permanent perpetuation of the record to a medium. Furthermore, neither the time span of the storage nor the existence of other flight records is necessary for reliability. This leads to the situation that, in contrast to non-computerized records, old records do not need to be kept for the reliability of new records.

e) Form and manner by the competent authority

It is questionable, to what the „*form and manner*" that is to be established by the competent authority refers to. Given the wording and structure of FCL.050,[547] the form and manner could relate to the „*reliable record*", the „*details*" or „*all flights flown*". AMC1.FCL.050 does not give a hint about how this provision might be interpreted according to this question.

The phrasing of „*form and manner*" may be pointing towards the term „*reliable record*" for the fact that only the record can have a different form. However, the reliability of the records is to be seen as a minimum requirement, which is not negotiable. The competent authority is not entitled to set lower standards. In addition, if a pilot stores records in a way that the reliability of the used method exceeds the reliability of the standard procedure it would be unduly to deny that method.

In terms of „*all flights flown*" FCL.050 is strict and does not leave room for any interpretation. Although this requirement is interfering with data protection law[548] and the German solution[549] is preferable, the competent authority does not have the power to alter this con-

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[546] V.s. F II 1 d aa), *Wording*, p. 64.

[547] „*The pilot shall keep a reliable record of the details of all flights flown in a form and manner established by the competent authority.*"

[548] V.s. F II 1 d), *All flights flown*, p. 64.

[549] V.s. F II 1 d aa), *Wording*, p. 64.

dition. Lastly, the form and manner could relate to the „*details*" of the flight records. The details are not laid down by FCL.050 and AMC.1 FCL.050 established a minimum set of items that have to be recorded.[550] Therefore, the competent authority may constitute the recording of more details. If additional details will be required, the recording of the details has to be for a clear purpose and the details need to be necessary for this purpose.

2. Concerning the aircraft

According to M.A.305 lit. b) № 1,[551] the aircraft continuing airworthiness shall consist of, inter alia, an aircraft logbook. A definition for the aircraft logbook in EASA related regulations directly, however, is missing.[552]

„*Particulars of the aircraft, its crew and each journey shall be retained for each flight, or series of flights, in the form of a journey log, or equivalent*", ORO.MLR.110[553]. The same phrasing is used in OPS.GEN.610,[554] SPO.GEN.145[555] and NCO.GEN.154[556]. What shall be included in a journey log according to the EASA is listed in AMC1 ORO.MLR.110 lit. a).

Concerning the format of the journey log, AMC.1 ORO.MLR.110 lit. b) states that „*[t]he information, or parts thereof, may be recorded in a form other than on printed paper. Accessibility, usability and reliability should be assured.*"[557] Therefore, the same principles and findings of the reliable flight records[558] apply to the journal log due to the similarity and even safety levels.

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[550] V.s. F II 1 b), *Details*, p. 58.

[551] Annex I to Commission Regulation (EC) No 2042/2003.

[552] OPS 1.1055 Annex III Commission Regulation (EC) No 859/2008 defines the term journey log. The EU-OPS (Annex III Commission Regulation (EC) No 859/2008) are to be replaced step by step by Annexes to Commission Regulation (EC) No 965/2012: EUROPEAN AVIATION SAFETY AGENCY [2012], *Transitional period stemming from the Proposal on Air Operations/Commercial Air Transport*, <http://www.easa.europa.eu/flightstandards/doc/Note_on_transition_OPS-CAT.pdf>.

[553] Annex III Commission Regulation (EU) No 965/2012.

[554] NPA 2009-02b.

[555] Annex VIII of the draft Commission Regulation on 'Air Operations - OPS'.

[556] Annex VII of the draft Commission Regulation on 'Air Operations - OPS'.

[557] Formulation also used in AMC OPS.GEN.610 (NPA 2009-02b).

[558] V.s. F II 1., *Concerning the Pilot In Command*, p. 58.

G. Conclusion

The structure and applicability of the rules concerning aviation in the sphere of the EASA is quite confusing. The overview[559] of the different regulations and its annexes might look very distinct at first glance. However, when not all regulations came into force, when there are opt-out possibilities for the Member States and when AMC and GMs are not binding but somehow bind competent authorities, the rules become perplexing. In addition, the rules are not making use of a parenthesis-structure like the German Civil Code. In such a structure, general rules are placed outside the brackets and only differing rules will be stated for special areas, making wide use of the lex specialis derogat legi generali principle. Since that structure is not used, there are very similar rules in wording and structure bloating the legal sources unnecessarily.[560]

The analyzation of the subject in this thesis has shown that often there is no clash between „*Pen and Paper*" and „*Bits and Bytes*". In fact, quite the opposite was the case. Most rules are refreshingly technology neutral and are focussing on the outcomes with regard to safety and practicability. One of the outcomes of the research is that „*the concept of safety as an absolute prerequisite for all aviation activities*"[561], disregarding whether or not the concerned solutions are digital. For the concerned pilots, as it turns out, are sometimes „*Pen and Paper*" solutions more convenient than those in „*Bits and Bytes*".[562] At some points, however, the use of IT tears security holes open. The legislator is well advised to fix approaches that are broken by design as soon as possible.[563]

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[559] EUROPEAN AVIATION SAFETY AGENCY [2013], *Rulemaking Regulations*.

[560] E.g. FCL.140.A, FCL.140.H, FCL.140.S, FCL.140.B and FCL.230.B.

[561] *Weber* in: GIEMULLER/WEBER [2011], *International and EU Aviation Law*, p. 285.

[562] The documentation of conducted flights is way more convenient on pen & paper than with bits & bytes.

[563] Ensuring integrity and authenticity of real-time flight data for example.

Legal sources

Bilateral and multilateral treaties:

BASA
AGREEMENT BETWEEN THE UNITED STATES OF AMERICA AND THE EURO-
PEAN COMMUNITY ON COOPERATION IN THE REGULATION OF CIVIL AVIATION
SAFETY

CFREU
CHARTER OF FUNDAMENTAL RIGHTS OF THE EUROPEAN UNION (2000/C 364/01)

Chicago Convention
CONVENTION ON INTERNATIONAL CIVIL AVIATION, SIGNED AT CHICAGO, ON 7
DECEMBER 1944

ECHR
European Convention on Human Rights as amended by Protocols Nos. 11 and 14 supple-
mented by Protocols Nos. 1, 4, 6, 7, 12 and 13

EPC
Convention on the Grant of European Patents
(European Patent Convention)
of 5 October 1973 as revised by the Act revising Article 63 EPC of 17 December 1991 and the
Act revising the EPC of 29 November 2000

TEU
CONSOLIDATED VERSION OF THE TREATY ON EUROPEAN UNION

TFEU
CONSOLIDATED VERSION OF THE TREATY ON THE FUNCTIONING OF THE EU-
ROPEAN UNION

UDHR
Universal declaration of human rights

Directives:

Directive 91/250/EEC
Council Directive 91/250/EEC of 14 May 1991 on the legal protection of computer programs

Directive 1995/46/EC
Directive 95/46/EC of the European Parliament and of the Council of 24 October 1995 on
the protection of individuals with regard to the processing of personal data and on the free
movement of such data

Directive 97/7/EC
DIRECTIVE 97/7/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of
20 May 1997 on the protection of consumers in respect of distance contracts

Directive 1999/93/EC
Directive 1999/93/EC of the European Parliament and of the Council of 13 December 1999
on a Community framework for electronic signatures

Directive 2001/29/EC
DIRECTIVE 2001/29/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 22 May 2001 on the harmonisation of certain aspects of copyright and related rights in the information society

Directive 2002/65/EC
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Directive 2002/92/EC
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Directive 2004/18/EC of the European Parliament and of the Council of 31 March 2004 on the coordination of procedures for the award of public works contracts, public supply contracts and public service contracts

Directive 2009/24/EC
DIRECTIVE 2009/24/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 April 2009 on the legal protection of computer programs

Directive 2011/83/EU
DIRECTIVE 2011/83/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 25 October 2011 on consumer rights, amending Council Directive 93/13/EEC and Directive 1999/44/EC of the European Parliament and of the Council and repealing Council Directive 85/577/EEC and Directive 97/7/EC of the European Parliament and of the Council

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REGULATION (EC) No 1592/2002 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 15 July 2002 on common rules in the field of civil aviation and establishing a European Aviation Safety Agency

Regulation (EC) No 549/2004
REGULATION (EC) No 549/2004 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 10 March 2004 laying down the framework for the creation of the single European sky (the framework Regulation)

Regulation (EC) No 550/2004
REGULATION (EC) No 550/2004 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 10 March 2004 on the provision of air navigation services in the single European sky (the service provision Regulation)

Regulation (EC) No 551/2004
REGULATION (EC) No 551/2004 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 10 March 2004 on the organisation and use of the airspace in the single European sky (the airspace Regulation)

Regulation (EC) No 552/2004
Regulation (EC) No 552/2004 of the European Parliament and of the Council of 10 March 2004 on the interoperability of the European Air Traffic Management network (the interoperability Regulation)

Regulation (EC) No. 216/2008
REGULATION (EC) No 216/2008 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 20 February 2008 on common rules in the field of civil aviation and establishing a European Aviation Safety Agency, and repealing Council Directive 91/670/EEC, Regulation (EC) No 1592/2002 and Directive 2004/36/EC

Regulation (EC) No 1070/2009
REGULATION (EC) No 1070/2009 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 21 October 2009 amending Regulations (EC) No 549/2004, (EC) No 550/2004, (EC) No 551/2004 and (EC) No 552/2004 in order to improve the performance and sustainability of the European aviation system

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COMMISSION REGULATION (EC) No 859/2008 of 20 August 2008 amending Council Regulation (EEC) No 3922/91 as regards common technical requirements and administrative procedures applicable to commercial transportation by aeroplane

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Title: Position: Originator: Usage right:	**Figure 4:** Google Maps street route D I 2. Determination of the route on p. 43 Google Inc. A usage right is not required due to the limitations of the exclusive usage rights laid down in Art. 2, 3 and 4 Directive 2001/29/EC. The pertinent exemption is Art. Art. 5 № 3 lit. a) Directive 2001/29/EC for Art. 2 and 3, in the alternative Art. 5 № 3 lit. d) Directive 2001/29/EC. Art. 4 Directive 2001/29/EC is covered by Art. 5 № 4 Directive 2001/29/EC.
Title: Position: Originator: Usage right:	**Figure 5:** VFR flight route D I 2. Determination of the route on p. 44 Map: ICAO Strokes: Sebastian Höhne (*1984) A usage right is not required due to the limitations of the exclusive usage rights laid down in Art. 2, 3 and 4 Directive 2001/29/EC. The pertinent exemption is Art. Art. 5 № 3 lit. a) Directive 2001/29/EC for Art. 2 and 3, in the alternative Art. 5 № 3 lit. d) Directive 2001/29/EC. Art. 4 Directive 2001/29/EC is covered by Art. 5 № 4 Directive 2001/29/EC.

Title:	**Figure 6:** VFR flight route
Position:	D III 1. Automatization of the calculations on p. 49
Originator:	FL95.de
Usage right:	A usage right is not required due to the limitations of the exclusive usage rights laid down in Art. 2, 3 and 4 Directive 2001/29/EC. The pertinent exemption is Art. Art. 5 № 3 lit. a) Directive 2001/29/EC for Art. 2 and 3, in the alternative Art. 5 № 3 lit. d) Directive 2001/29/EC. Art. 4 Directive 2001/29/EC is covered by Art. 5 № 4 Directive 2001/29/EC.
Title:	**Figure 7:** Flight route visualized on Google Maps
Position:	D V. Accuracy on p. 51
Originator:	Map: Google Inc.
	Route overlay: GPSX Viewer provided by Bernhard Gaul
Usage right:	A usage right is not required due to the limitations of the exclusive usage rights laid down in Art. 2, 3 and 4 Directive 2001/29/EC. The pertinent exemption is Art. Art. 5 № 3 lit. a) Directive 2001/29/EC for Art. 2 and 3, in the alternative Art. 5 № 3 lit. d) Directive 2001/29/EC. Art. 4 Directive 2001/29/EC is covered by Art. 5 № 4 Directive 2001/29/EC.
Title:	**Figure 8:** Flying Logbook
Position:	F II 1. Concerning the Pilot In Command on p. 58
Originator:	Logbook: Luftfahrtverlag Friedrich Schiffmann
	Entries: Sebastian Höhne (*1984)
Usage right:	A usage right is not required due to the limitations of the exclusive usage rights laid down in Art. 2, 3 and 4 Directive 2001/29/EC. The pertinent exemption is Art. Art. 5 № 3 lit. a) Directive 2001/29/EC for Art. 2 and 3, in the alternative Art. 5 № 3 lit. d) Directive 2001/29/EC. Art. 4 Directive 2001/29/EC is covered by Art. 5 № 4 Directive 2001/29/EC.

About the author

Dipl.-Jur. Sebastian Höhne, born on the 5th of February 1984 in Hannover, studied law from 2003 to 2011 with the specialization in IT law and intellectual property (2010 to 2011, Institut für Rechtsinformatik). The undergrad thesis for the IT law specialization was written about the question „*Ist die Abnahme und Untersuchung einer Blutprobe im Rahmen eines Bewerbungsverfahrens zulässig?*"*. From 2012 to 2013 he was part of the European Legal Informatics Study Programme (EULISP-18) in the double degree Oslo-Hannover variant to obtain the degree Master of Laws (LL.M.) from both universities.

While studying he was also active occupationally:
He did an apprenticeship as a merchant in wholesale and foreign trade from 2004 to 2006 with honors, achieving the 1st place award as the regional champion from the local chamber of commerce in 2006.

Since 2007 he administrates JustFirms.com, a business unit of the HOEHNE AG, which offers professional video hosting for commercial purposes.

His newest invention, and also a business unit of the HOEHNE AG, is an image file size optimization service for speeding up websites and search engine optimization, www.Website-Speed.info, established in 2012.

He is holding a Private Pilot Licence (Aeroplane) issued under the regulations of the ICAO for Single-Engine piston (land) with an MTOW of 2000 kg since the 26th of August 2002. The examination for a CVFR rating was passed on the 30th of July 2013.

* The topic was randomly assigned to the author; translation: "Is the drawing and analyzation of blood in an application procedure permissible?"

Thanks to my airmen companions

Achim Wendt †
   With whom I had my first (unofficial) flight lesson

Tom Freytag
   With whom I had my first (official) flight lesson

Peter Berghoff
   Who taught & teaches flight students, including me, with great passion

Michael Ruhsert
   Who has audited & checked my style of flying more than once

Jürgen Houcken
   Who dedicated & dedicates a huge amount of time and energy due to his function
   as the president to the AeroClub Hildesheim-Hannover e.V.

All Members of the Aero Club Hildesheim-Hannover e. V.
   Who share the passion of flying and with whom I had & have a really good time

Insurance & additional information

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(**Dipl.-Jur. Sebastian Höhne**)

Theaterstraße 14 C
30159 Hannover
Germany

sebastian@hoehne.ag
http://www.hoehne.net

PS: Always happy landings!