

FLIGHTZOOMER 1.5

INSTALLATION

1 Contents

2	Disc	claime	۲	3
3	Inst	allatio	on	4
	3.1	Wha	it hardware do you need?	4
	3.2	Prep	pare the FlightZoomer Relay Server	5
	3.2.	1	Shall it run in the cloud or at home?	5
	3.2.	2	Select a virtual machine provider	6
	3.2.	3	Create a virtual machine instance on Microsoft Azure	7
	3.2.	4	Provide DNS capabilities	2
	3.2.	5	Configure port forwarding 1	.3
	3.2.	6	Install the FlightZoomer relay server application 1	.6
	3.2.	7	Open the firewall for the required ports 1	.8
	3	.2.7.1	Opening the firewall on your PC at home1	.8
	3	.2.7.2	Opening the firewall on the virtual machine1	.8
	3.2.	8	Start the virtual machine	22
	3.2.	9	Connect to the running virtual machine	23
	3	.2.9.1	Accessing the remote machine from your PC 2	24
	3	.2.9.2	Accessing the remote machine from your phone 2	27
	3.2.	10	Shutdown the VM after usage to minimize charges 2	29
	3.3	Prep	pare the FlightZoomer Sensorics-app	30
	3.3.	1	Attach the sensor smartphone	30
	3	.3.1.1	Best practices	31
	3.3.	2	Install the app	86
	3.3.	3	Install and configure MAVLink connectivity	86
	3.3.	4	Prepare the app	10
	3.4	Prep	pare the FlightZoomer Groundstation-app4	1
	3.4.	1	Attach the device to the RC transmitter (optional)4	1
	3.4.	2	Install the app 4	1
	3.4.	3	Prepare the app	12
	3.5	Prep	pare the RC system 4	12
	3.5.	1	Speed hold/autothrottle mode 4	13
	3.5.	2	Constant turn mode	13
	3.5.	3	Example	4
	3.6	Prep	pare the navigation database4	4
4	Арр	endix		ł5
4.1 Glossary				15

2 Disclaimer

While FlightZoomer offers fantastic features, the following operation rules are strictly to be followed:

- The system is intended for hobby usage.
- Be familiar with the operation of RC aircraft having 1kg flying weight or more.
- Use FlightZoomer only aboard a proved combination of RC equipment, airframe, flight controller, motors, propeller, battery and ESCs.
- Operate FlightZoomer strictly within the safety boundaries of any other used components.
- Operate FlightZoomer strictly within the boundaries of any local regulatory requirement.
- Fully respect any disclaimer and safety note which is associated with any other used component.

3 Installation

3.1 What hardware do you need?

Related to FlightZoomer operations:

Component	Required equipment	Specifications	Mandatory	Recommended
FlightZoomer Sensorics	Windows Phone 8 or higher device	 Mobile plan with decent data support 	Х	
		- Supports Bluetooth		X (highly)
		 Compass sensor 		Х
FlightZoomer Groundstation	Windows Phone 8 or higher device	 Mobile plan with decent data support 	Х	
		- Support Bluetooth		Х
		- 6" display		Х
FlightZoomer	PC or Server with	- Internet connection	Х	
Relay Server	Windows 7 or higher, located at home or alternatively in the cloud	 High availability/ unattended operation 	Х	
Stabilizing	Flight controller;	 Support stabilized flight 	Х	
unit	FlightZoomer has been tested with the APM/Pixhawk derivative AUAV X2.	 Ardupilot based 		Х
		 Support fully redundant failback (e.g. RETURN-TO- LAUNCH -mode) 	Х	
		 Offer MAVLink connectivity using the APM flavor 		X (highly)
MAVLink bridge	Bluetooth transceiver HC-06 or compatible (e.g.	 The UART side must be compatible with the flight controller 		X (highly)
	from 3DR or Ebav)	_		

Not related to FlightZoomer itself you need the following equipment minimally:

Component	Required equipment	Specifications	Mandatory	Recommended
Aircraft	RC airplane or multicopter	 Fully equipped in flyable condition also without FlightZoomer 	x	
		- Unproblematic handling		Х
		- Electric propulsion		Х
Radio system	Radio transmitter and receiver	 Possibility to command constant yaw 		Х
		 Possibility to command constant pitch 		х

3.2 Prepare the FlightZoomer Relay Server

3.2.1 Shall it run in the cloud or at home?

The relay server principally can be operated unattended. For the normal operation scenario the relay server needs to be started and that's it.

There are two possibilities to run the FlightZoomer Relay Server application.

- 1. On a cloud-based virtual machine
- 2. On your own PC (at home).



It is recommended, to us the cloud option because of these advantages:

- You do get a DNS service out of the box. If the relay server runs at home, an extra DNS service needs to be provided.
- The UDP port forwarding requirement can be implemented in a common and easy way.
- Access on the virtual machine is easily possible from the phone. This means that the relay server can be accessed from any place (e.g. from the outdoor location where you are flying). This is normally not needed, but in some cases it could turn out to be advantageous (e.g. if you forgot to launch the application at home).

Disadvantages of a cloud based relay server would be:

- There is a fee for a cloud based virtual machine (VM). There are price models however, which charge per operating hour, which means that per flight the price would only be some cents.
- Cloud dependency.

The following lists shows the steps needed to prepare the relay server:

One-time installation steps:

Step		
Select a virtual machine provider	Х	
Create a virtual machine instance	Х	
Provide DNS capabilities		х
Configure port forwarding		Х
Install the FlightZoomer Relay Server application	Х	Х
Open the firewall for the required ports	Х	Х

Recurrent preparation steps:

Step		
Start the virtual machine	Х	
Access the virtual machine (from a PC and from a smartphone)	х	
Shutdown the virtual machine after usage	Х	

More details about any of these steps in the following chapters.

3.2.2 Select a virtual machine provider

This step is needed for:



While there are tons of VPS providers in the Internet, it is recommended to run the FlightZoomer Relay Server application on Microsoft Azure. Other providers often focus on virtual Linux boxes while FlightZoomer requires a virtual Windows machine. It is paid per usage hours so the fees for FlightZoomer purposes are really very moderate. The following guidelines describe the usage of an Azure virtual machine.

3.2.3 Create a virtual machine instance on Microsoft Azure

This step is needed for:



For this step first a Microsoft Azure account needs to be opened. Login into Azure from this page. If you don't have a Microsoft account yet, click on *signup up now* first (but you should already have one if you have set up your Windows Phone devices properly):

Azure login

After that the following steps are needed:

Step 1: Go to the Management Portal

Here you can see all items that you have created so far...

Now click on VIRTUAL MACHINES on the left hand menu bar



Step 2: Virtual machines screen

Here you can create a new virtual machine. Click on the red-marked link to do that:

		- • ×
https://manage.windowsazure.com/	/(𝒫 ▾ 🖨 ở 🔤 📫 Virtual machines - Window ×	₼ ☆ ऄ
<u>File Edit View Favorites Tools H</u> elp		
Microsoft Azure 🛛 🗸	⊕ <azure id="" user=""></azure>	^
ALL ITEMS	virtual machines Instances Images Disks	
	No virtual machines have been created. To get started, click	
MOBILE SERVICES	Create a virtual machine. create a virtual machine ④	
DB SQL DATABASES		
STORAGE 0		
New! Manage all your virtu	al machines in the Azure Preview portal. TRY PREVIEW 🔗 NOT NOW 🛞 DON'T ASK AGAIN 🛞	
- New	Ū DELETE 1 🗠 🕐	~

Step 3: Create new virtual machine screen

Here select COMPUTE > VIRTUAL MACHINE > FROM GALLERY

					- • ×
(←)⊕∎	https://manage.windowsazure.com/《 🔎	マ 🔒 🖒 👯 Virtual machines - Window	×		🟠 🖈 🔅
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	Microsoft Azure 🛛 🗸			AZURE user ID>	~
	NEW			×	
	Г СОМРИТЕ	WEB SITE			
	DATA SERVICES		FROM GALLERY		
	APP SERVICES				
	STORE PREVIEW				
		.cloudapp.net			~

Step 4: Image selection screen

From the various options choose Windows Server 2008 R2 SP1. It is good enough by far for our purposes:



Step 5: Configuration screen I

Provide a name for the virtual machine (red box), the machine size (green box) and a user name, for later login purposes (blue box). Note the specified names for later usage. Also provide a password for the user, which will be used to login from now on. This user is only created on the new virtual machine:

- D - https	s://manage.windowsazure.com/(D 👻 🔒 C		₼ ☆ \$
<u>F</u> ile <u>E</u> dit <u>V</u> iew	F <u>a</u> vorites <u>T</u> ools <u>H</u> elp		
	create a virtual machine Virtual machine configuration	×	^
	VERSION RELEASE DATE 7/21/2014 VIRTUAL MACHINE NAME (Vour VM name) VIRTUAL MACHINE NAME BASIC STANDARD SIZE A2 (2 cores, 3.5 GB memory) NEW USER NAME [Your VM user name] NEW PASSWORD CONFIRM CONFIRM CONFIRM CONFIRM CONFIRM CONFIRM	Windows Server 2008 R2 Sp1 Windows Server 2008 R2 is a multi- purpose server designed to increase the reliability and flexibility of your server or private cloud infrastructure, helping you to save time and reduce costs. It provides you with powerful tools to react to business needs with greater control and confidence. SFAMILY Windows PUBLISHER Microsoft Windows Server Group DISKS 1 LOCATIONS EACHINES EACHINES COLORINES COLORINES PRIVE Assig-Southeast Asia-Brazil COLORINES COLORINES PRIVE Asia-Southeast Asia-Brazil COLORINES PRIVE Asia-Southeast Asia-Brazil PRIVE Asia-Southeast Asia-Southeast Asia-Brazil PRIVE Asia-Southeast Asia-Brazil PRIVE Asia-Southeast Asia-Brazil PRIVE Asia-Southeast Asia-Southeast Asia-Brazil PRIVE Asia-Southeast Asia-Brazil PRIVE Asia-Southeast Asia-Southeast Asia-Brazil PRIVE Asia-Southeast Asia-Southeast Asia-Brazil PRIVE Asia-Southeast Asia-Brazil PRIVE Asia-Southeast Asia-Southeast Asia-Southeast Asia-Southeast PRIV	4 v

A remark regarding the machine size: it is recommended to choose A2 or higher

Step 6: Configuration screen II

On this page the public name of the virtual machine (red box) and the UDP port forwarding shall be specified. Here the DNS name shall be kept ready for later usage. Also select the region which is located the closest to places you usually fly (yellow box). Also add an endpoint as shown in the blue/green boxes:

		- 🗆 🗙
🗲 🕘 🕂 https://manage.windowsazure.com/{ 🖉 🗧 🖨 🕈 👫 Virtual machines - Window 🗙		\Lambda 🖈 🕸
Eile Edit View Favorites Tools Help		
create a virtual machine Virtual machine configuration	×	Ŷ
CLOUD SERVICE Create a new cloud service Create a new cloud service Create a new cloud service Course summer of the cloud app.net reconversion course area of the cloud app.net Processing course area of the cloud app.net West Europe STORAGE ACCOUNT Use an automatically generated storage account AVAILABILITY SET NAME PROTOCOL PUBLIC PORT PRIVATE PORT NAME PROTOCOL PUBLIC PORT PRIVATE PORT Remote Desktop TCP STORAGE 5986 S986 S986 FightZoomer UDP ST7778 X	Windows Server 2008 R2 SP1 Windows Server 2008 R2 is a multi- purpose server designed to increase the reliability and flexibility of your server or private cloud infrastructure, helping you to save time and reduce costs. It provides you with powerful tools to react to business needs with greater control and confidence. OS FAMILY Windows PUBLISHER Microsoft Windows Server Group NUMBER OF DISKS 1 LOCATIONS East Asia(Southeast Asia)Brazil COMMINICATION PRICING INFORMATION Pricing varies based on the subscription you select to provision your virtual machine.	v

The information on this page is all that you need for connecting both the Sensorics- and the Groundstation-app to the relay server. In both apps you would enter the Network Address on the add relay server screen according to this pattern:



Step 7: Configuration screen III

Here just pick the suggested options and finalize the order with the button on the right hand bottom:



Step 8: Virtual machine screen, creation status

On bottom of this screen you can see the virtual machine creation progress. After creation, the VM will be running:

Altps://manage.windowsazure.com File Edit View Envertise Tools Hele	n/ℓ P = ≜ C III Virtual machines - Window ×	n ★ \$
Microsoft Azure	⊕ <azure id="" user=""></azure>	^
ALL ITEMS	virtual machines	
WEB SITES	INSTANCES IMAGES DISKS	
VIRTUAL MACHINES	NAME 🔶 STATUS SUBSCRIPTION LOCATION DNS NAME 🔎	
	[Your VM Name] * Starting (Provisioning) Nutzungsbasierte Bezahl West Europe [VM DNS Name]	
B SQL DATABASES		
New! Manage all your virtu	tual machines in the Azure Preview portal. TRY PREVIEW 🔗 NOT NOW 🗴 DON'T ASK AGAIN 🗴	
← Creating the virtual	I machine	
 Successfully created storage Setting up virtual machine 	age account for virtual machine e	
- New	メ う じ ピ と 合 団 1 1 1 1 で Connect Restart Shut down Attach Defach disk capture Delete 1 1 1 1 2 ??	~

Here the virtual machine has been created successfully and is running. At this point there are two options:

- Connect to the instance using a Remote Desktop Client (RDP Client) -> go to chapter 3.2.9
- If you are not using the VM at the moment, switch it off avoiding charges -> go to chapter 3.2.10

				×
File Edit View Eavorites Tools Help	Virtual machines - Window	×		\$P\$ 次 金
Microsoft Azure			AZURE user ID>	^
ALL ITEMS	virtual machines			
	INSTANCES IMAGES DISKS			
	NAME	SUBSCRIPTION LOCATION	DNS NAME	
	[Your VM Name] → ✓ Running	Nutzungsbasierte Bezahl West Europe	[VM DNS Name]	
DB SQL DATABASES				
STORAGE 0				
✓ Successfully created virtual n	nachine.		details 🚺 ok 父	
	CONNECT RESTART SHUT DOWN A		1 \Xi 😮	v

After creating the virtual machine for the first time, it is already running. In case you do not continue, don't forget to shut down the virtual machine as described in chapter 3.2.10.

3.2.4 Provide DNS capabilities

This step is only needed for:



While using the Azure based virtual machine, the DNS service is already available out of the box.

If you are using a PC at home, you need to configure a DNS service accordingly.

The DNS serves the purpose, that the relay server can be reached from any point in the Internet via a public name (like google.com is a name that can be reached from anywhere in the internet). Actually the public

name will resolve to the public IP address of your internet router or modem. Reaching the relay server from the router is explained in the next chapter.

The public name of your relay server needs to be entered as relay-server network address in both the Sensorics- as well as the Groundstation-app.

DNS services require a DNS provider and some configuration in your router that the actual public IP address of your home endpoint gets reported to the provider.

There is a large variety of DNS providers. Some of them have been free, but no longer are (<u>dyndns</u>), some are pseudo-free (<u>noip</u>) and some are really free (<u>FreeDNS</u>).

Setting up DNS services requires these steps:

- 1. Pick a suitable DNS provider
- 2. Get an account
- 3. Set up everything as explained by the DNS provider in your modem/router.

3.2.5 Configure port forwarding

This step is only needed for:



While using the Azure based virtual machine, the port forwarding is already available out of the box.

If you are using a PC at home, you need to configure your internet router accordingly.

What basically is needed, is that UDP messages reaching your public home IP address are forwarded to the PC, where the relay server application runs.

The method, how to do that differs from router to router. Therefore the required settings are only shown here exemplarily for the Fritzbox 7390 Router:

Step 1: Overview page for the port forwarding feature:

	18.1/ D -	C 🔶 FRITZ!Box	×				- □ × ☆ ☆
<u>File E</u> dit <u>V</u> iew F <u>a</u> vorites	<u>T</u> ools <u>H</u> elp						
FRITZ!		FRIT	Z!Box7	/39	0		
			Logg	ed in 🔻	FRITZ!Box Login FR	ITZ!NAS MyFRITZ!	1
Overview	Permit Acc	ess					
Internet	Bort Forward	ling Storago E	DITZIDay Sandicas	Dynami			
Online Monitor	PortForward	ing Storage F	KITZIBUX Services	Dynami			
Account Information	Computers con	nected to FRITZ!Box are	e safe from unauthori	zed acces	s from the Internet. Howev	er, for certain applications s	uch as
Filters	online games o	r the eMule file sharing p	program, it must be p	ossible fo	other users in the Internet	to access your computer. S	uch
Permit Access	connections are	e made possible by enab	ling port forwarding.				
MyFRITZ!	List of Ports w	ith Port Forwarding En	abled				
Telephony	Enabled	Name	Protocol	Port	to Computer	to Port	
Home Network	\checkmark	FZRDVServer1	UDP	57778	LP0006-LAN	57778	×
WLAN						New Port Forv	varding
DECT							
System	Allow chang	ges to security settings o	ver UPnP				
	Devices ar the FRITZ! connection	d applications that supp Box port forwarding rules s from the Internet.	ort UPnP can be use s. For reasons of sec	d to chang urity, only	ge security settings in the h enable this option if you re	ome network automatically, ally want to allow incoming	such as
				Ap	ply Cancel	Refresh He	lp 🗸

Step 2: Detail page for the relay server port forwarding:

🔿 🔶 http://192.168.188	3.1/ ♀ ♂ I I I I I I I I I I I I I I I I I I
e <u>E</u> dit <u>V</u> iew F <u>a</u> vorites]	[ools Help
FRITZ	F _R I _T Z!Box 7390
	Logged in 🔻 <u>FRITZ!Box Login</u> FRITZ!NAS MyFRITZ! 🧃
Overview	Port Forwarding
Internet Online Monitor Account Information	Edit port forwarding Image: Second state Image: Second state Image: Second state Image: Second state Image: Second state Image: Second state
Filters	Name FZRDVServer1
Permit Access	Protocol UDP V
MyFRITZ!	From port 57778 through port 57778
Telephony Home Network WLAN	to computer LP0006-LAN V to IP address 192.168.188.10
DECT	to Port 57778
System	OK Cancel Help
	View: Advanced Contents Manual Newsletter avm.o

Whatsoever this screen looks for your router, you need to configure an UDP port forwarding from the listening port 57778 to the IP address and port 57778 of the PC, where the relay server runs upon.

At this point there is a public URL pointing to your house (see the chapter before) and a port forwarding to connect the public network endpoint with the relay server. The related parameter can be used to connect both the Sensorics- and the Groundstation-app to the relay server. In both apps you would fill in the *Network Address* according to this pattern (on the *add relay server*-screen):

[Your public DNS nam	ne]	:	57778
FLIGHTZOOMER SENSORICS add relay serv Name [Define name of relay serv Network Address	rer]	er	
[Enter URL or IP Address]			D
[Enter URL or IP Address] Save	ancel		

3.2.6 Install the FlightZoomer relay server application

This step is needed for:



Step 1: Go to <u>http://flightzoomer.com/downloads.html</u> and download the latest version of the FlightZoomer Relay Server application:

_				×
← ⊕ 🛃 http://flightzoomer.c タ マ ♂	P flightzoomer.com	×	☆ ★	₽
				^
	FlightZoc	omer		
Hello, welcome on th As I don't want to spend a lot of tir appear a bit minimalistic. But o	is page and thank you ne designing this webp lon't turn away, the gis	for your interest in F page, so the design t of the matter is the	FlightZoomer! and the features of it might FlightZoomer system!	
> What is it about? FlightZoomer	n a nutshell			
> Get Started! Find way more info	rmation in the produ	ct documentation		
Downloads				
Here you can download the latest FlightZoo System requirements: A Windows PC with Windows 7 or more. Al see on your computer!	mer Relay Server applicati the files are guaranteed to	on, which needs to be ir be free and clean from	nstalled on a PC at home. any stuff you will never want to	
Application	Version	Filename	Size	
FlightZoomer Relay Server	1.0.0.8	setup.1.0.0.8.exe	6.99 MB	
				\sim

Step 2: Add flightzoomer.com to the list of trusted websites (only on 👔)

When the download link from flightzoomer.com is clicked, a warning pops up. Add flightzoomer.com to the trusted websites as shown. The reason for this is that the operating system on the virtual machine is not plain vanilla Windows but the Server version which has higher security standards.

Internet Explorer Enhanced Security Configuration is enabled - Internet Explorer	7		
Fers is rest; if setup.dilytardAdmin.htm Image: Control of the setup.dilytardAdmin.htm Image: Control of the setup.dilytardAdmin.htm Image: Control of the setup.dilytardAdmin.htm Image: Control of the setup.dilytardAdmin.htm Image: Control of the setup.dilytardAdmin.htm	🗧 🎽 🌈 Internet Explorer Enhan	Security Configuration is enabled - Internet Explorer	- 🗆 🗵
For the standard sector information, see Hanaging intermet Explorer and the fing a set of the sector information is the local intranet or Trusted sites Intermet Explorer Enhanced Security Configuration is currently enabled on your server. This configures a number of security settings that define how users browse Intermet and intranet Web sites. Intermet Explorer Enhanced Security Configuration is currently enabled on your server. This configures a number of security settings that define how users browse Internet and intranet Web sites. Intermet Explorer Enhanced Security Configuration is currently enabled on your server. This configures a number of security settings that define how users browse Internet and intranet Web sites. Intermet Explorer and restrict access to network resources, such as files on Universal Naming Convention (UNC) Intermet Explorer and restrict access to network resources, such as files on Universal Naming Convention (UNC) Intermet Explorer and restrict access to network resources, such as files on Universal Naming Convention (UNC) Intermet Explorer and restrict access to network resources, such as files on Universal Naming Convention (UNC) Intermet Explorer and restrict access to network resources, such as files on Universal Naming Convention (UNC) Intermet Explorer and restrict access to network resources, such as files on Universal Naming Convention (UNC) Intermet Explorer and restrict access to network resources, such as files on Universal Naming Convention (UNC) Intermet Explorer and restrict access to network resources, such as files on Universal Naming Convention (UNC) Intermet Explorer and restrict access to network resources, such as files on Universal Naming Convention (UNC) Intermet Explorer and restrict access to network resources, such as files on Universal Naming Convention (UNC) Intermet Explorer and restrict access to network resources, such as files on Universal Naming Convention (UNC) Intermet Explorer and r	Recy 🕞 🕞 🗢 🌽 res://iesetu	HardAdmin.htm \mathcal{P} 🛃 🍫 🥥 Internet Explorer Enhanced X	₼ ☆
Learn more about Internet Explorer's Enhanced Security Configuration. If you that this website, you can lower security settings for the by adding to the Trusted sites zone. If you that this website to ony our local internet revew help internet revewer help internet revewer help internet revewer help internet revewer help int		ternet Explorer Enhanced Security Configuration is currently enabled on your server. This configures a number of security settings that define how users browse. Internet and intranet Web is configuration also reduces the exposure of your server to Web sites that might pose a security risk. For a complete list of the security settings in this configuration, see <u>Effects of Internet</u> Explorer Enhanced Security Configuration. There is the state of the security settings in this configuration, see <u>Effects of Internet</u> Explorer Tenhanced Security Configuration. There is the state of the security settings in the configuration of the security settings in the local intranet or Trusted set security can prevent Web sites from displaying correctly in Internet Explorer and restrict access to network resources, such as files on Universal Naming Convention (U area. For more information, see <u>Managing Internet Explorer</u> Enhanced Security Configuration is unternet Explorer Enhanced Security Configuration is unternet Explorer information of your Trusted Sec and that might be the trust of all explored information information is seen the website is on your book internet Explorer's Enhanced Security Configuration is correctly settings for this zone. All websites from this zone, all websites in your book internet explorer internet or and the list is to be all obait internet. Firsted sites zone (1)/(1)/(1)/(1)/(1)/(1)/(1)/(1)/(1)/(1)/	A sites. ; ; NC) tes

Step 3: Download the setup file and run it:

	1								
1	Internet Exp	olorer Enhan	iced Security C	onfiguration is enabled - 1	Internet Explorer				IX
Recy) - ()	🗿 http://flight	tzoomer.com/dow	nlnads/setun 1 0 0 3 e 🔘	🖌 🎸 🖄 Internet Evolorer Enhan	ced ×		d ⊕ ☆	£03
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				📜 Libraries 📄 Documents		FlightZoomer Relay Server Setup is preparing the InstallShield Wizard, which will guide you through the program setup process. Please wait.			
				 J Music ➡ Pictures ➡ Videos I Videos I Computer Attwork 		Extracting: FlightZoomer Relay Server.msi			
						Cancel			
				setup. 1.0.0.	.3 Date modified: 8/24/2014 12:46 PM	Date created: 8/24/2014 12:47 PM			~
				Pappication					
© Star	L 🕹	2		<u>ڪ</u>				DE DE 12	::47 PM 24/2014 🗖

3.2.7 Open the firewall for the required ports

This step is needed for:



In this chapter there are two sections. The first describes opening the firewall on your PC at home and the second shows how it is done on the virtual machine.

3.2.7.1 Opening the firewall on your PC at home

This task is very easy: when the FlightZoomer Relay Server application is started for the first time, the following pop up window will appear. Allow communication with the suggested networks and click on "Allow access":



3.2.7.2 Opening the firewall on the virtual machine

As the virtual machine operates a Windows Server operating system, the default security settings are higher. Therefore the following steps are needed:

Step 1: Click on the Windows Start-button and write "firewall"

Step 2: Open Windows Firewall with Advanced Security

Step 3: Create a new rule

=	🕷 Windows Firewall with Advance	d Security						×
<u></u>	File Action View Help	i4c74189a54e6cd01dc9ffbe						
Recycl	🗢 🔿 🖄 🖬 💼 🔒 👔 🖬							.191
	Private Strewall with Advanced S	Inbound Rules					Actions	.123
	Inbound Rules	Name	Group A	Profile	Enabled	Action 🔺	Inbound Rules	
	Connection Security Pulse	BranchCache Content Retrieval (HTTP-In)	BranchCache - Content Retrie	All	No	Allow	New Pule	
	Monitoring	BranchCache Hosted Cache Server (HTTP-In)	BranchCache - Hosted Cache	All	No	Allow	New Role	BNIFS
FlightZe		🕖 BranchCache Peer Discovery (WSD-In)	BranchCache - Peer Discovery	All	No	Allow	Y Filter by Profile	PERVER
Relay S		OM+ Network Access (DCOM-In)	COM+ Network Access	All	No	Allow	Filter by State	+
		OM+ Remote Administration (DCOM-In)	COM+ Remote Administration	All	No	Allow	N Shark Game	2008 R2
		🔮 Core Networking - Destination Unreachable (Core Networking	All	Yes	Allow	Y Hiter by Group	
		Ore Networking - Destination Unreachable	Core Networking	All	Yes	Allow	View	▶
		🔇 Core Networking - Dynamic Host Configurati	Core Networking	All	Yes	Allow	Refresh	-
		🔇 Core Networking - Dynamic Host Configurati	Core Networking	All	Yes	Allow	Kerresit	
		🔮 Core Networking - Internet Group Managem	Core Networking	All	Yes	Allow	Export List	
		Core Networking - IPHTTPS (TCP-In)	Core Networking	All	Yes	Allow	12 Help	
		🔮 Core Networking - IPv6 (IPv6-In)	Core Networking	All	Yes	Allow	1 Top	
		Ore Networking - Multicast Listener Done (I	Core Networking	All	Yes	Allow		
		Ore Networking - Multicast Listener Query (Core Networking	All	Yes	Allow		
		🔮 Core Networking - Multicast Listener Report	Core Networking	All	Yes	Allow		
		🔇 Core Networking - Multicast Listener Report	Core Networking	All	Yes	Allow		
		Core Networking - Neighbor Discovery Adve	Core Networking	All	Yes	Allow		
		Core Networking - Neighbor Discovery Solicit	Core Networking	All	Yes	Allow		
		Core Networking - Packet Too Big (ICMPv6-In)	Core Networking	All	Yes	Allow		
		Core Networking - Parameter Problem (ICMP	Core Networking	All	Yes	Allow		
		Ore Networking - Router Advertisement (IC	Core Networking	All	Yes	Allow		
		Ore Networking - Router Solicitation (ICMP	Core Networking	All	Yes	Allow		
		🔇 Core Networking - Teredo (UDP-In)	Core Networking	All	Yes	Allow		
		Ore Networking - Time Exceeded (ICMPv6-In)	Core Networking	All	Yes	Allow		
		🔮 DFS Management (DCOM-In)	DFS Management	All	Yes	Allow		
		🔮 DFS Management (SMB-In)	DFS Management	All	Yes	Allow		
		🔮 DFS Management (TCP-In)	DFS Management	All	Yes	Allow		
		🔮 DFS Management (WMI-In)	DFS Management	All	Yes	Allow		
		Obstributed Transaction Coordinator (RPC)	Distributed Transaction Coordi	All	No	Allow		
		Obstributed Transaction Coordinator (RPC-EP	Distributed Transaction Coordi	All	No	Allow		
		Signature Coordinator (TCP-In)	Distributed Transaction Coordi	All	No	Allow		
		🔮 File and Printer Sharing (Echo Request - ICM	File and Printer Sharing	All	No	Allow		
		File and Printer Sharing (Echo Request - ICM	File and Printer Sharing	All	No	Allow 👻	11	
		<u>د</u>				•		
A	. 🗊 👝 🚗 🗖	4					, , , , , , , , , , , , , , , , , , ,	DF 00 12:54 PM

Step 4: Select Port as firewall rule type

💮 New Inbound Rule Wizard	X
Rule Type	
Select the type of firewall rule to c	reate.
Steps:	
 Rule Type 	What type of rule would you like to create?
Protocol and Ports	
 Action 	C Program
Profile	Nule that controls connections for a program.
Name	Port Dela that control connections for a TCD as UDD and
	C Predefined:
	BranchCache - Content Retrieval (Uses HTTP)
	Nule mai controis connections for a windows experience.
	Custom rule
	Learn more about rule types
	/ Park News Concel

Step 5: Enter the options for the firewall

💣 New Inbound Rule Wizard	X
Protocol and Ports	
Specify the protocols and ports to	which this rule applies.
Steps:	
Bule Type	Does this rule apply to TCP or UDP?
Protocol and Ports	C ICP
 Action 	© UDP
Profile	
Name	Does this rule apply to all local ports or specific local ports?
(Specific local ports 57779
	Strangler 88, 443, 5000-5010
	Learn more about protocol and ports
	< <u>B</u> ack <u>N</u> ext > Cancel

Step 6: Allow the connection

Specify the action to be taker	when a connection matches the conditions specified in the rule.
Steps: Rule Type	What action should be taken when a connection matches the specified conditions?
Protocol and PortsAction	Allow the connection This includes connections that are protected with IPsec as well as those are not.
ProfileName	C Allow the gonnection if it is secure This includes only connections that have been authenticated by using IPsec. Connections will be secured using the settings in IPsec properties and rules in the Connection Security Rule node. Customize
	○ Bloc <u>k</u> the connection
	Learn more about actions

Step 7: Let this rule apply always

💣 New Inbound Rule Wizard	d X
Profile	
Specify the profiles for which this	s rule applies.
Steps:	
Rule Type	When does this rule apply?
Protocol and Ports	
Action	⊡ <u>D</u> omain
🥚 Profile	Applies when a computer is connected to its corporate domain.
Name	✓ Private
	Applies when a computer is connected to a private network location.
	Applies when a computer is connected to a public network location.
	Learn more about profiles
	< <u>B</u> ack <u>N</u> ext > Cancel

Step 8: Define the name of the rule (only for displaying purpose). Click on Finish afterwards.

💣 New Inbound Rule Wizard		×
Name		
Specify the name and description of th	iis rule.	
Steps:		
a Rule Type		
Protocol and Ports		
Action		
Profile	<u>Name.</u> EliabiZoomerlahound	
Name	riignz.comembound	
	Description (optional):	
	< <u>B</u> ack <u>F</u> inish Can <mark>l</mark> el	

3.2.8 Start the virtual machine

This step is needed for:



After creating the virtual machine for the first time, it is already running. If that is the case, skip this chapter and continue with the next chapter. Otherwise follow these steps, to start the virtual machine:

Step 1: Log first into your Azure Management site under https://manage.windowsazure.com

Step 2: Then enter the Portal at the top right.

Step 3: Click on VIRTUAL MACHINES in the menu on the left.

Step 4: The virtual machine can be started as shown on the following screen. Wait until *STATUS* shows *RUNNING* (this can take several minutes):



3.2.9 Connect to the running virtual machine

This step is needed for:



Like a real PC is accessed by taking a chair and sitting in front of it, a virtual machine needs to be accessed. For that purpose there is a program which is available on any Windows PC. This program is called Remote Desktop and allows to see the desktop of the virtual machine, as if you would sit in front of it.

In this chapter there are two sections. The first describes accessing the virtual machine from a desktop PC and the second shows how it is done via the phone.

Precondition is that your virtual machine shows the status RUNNING in the Azure Management site console (<u>https://manage.windowsazure.com</u>):



													- 🗆 🗙
K) 📫 http	os://manage.windowsazu	ire.c)		🖒 📫 Virtual	machines - Wi	ndow ×					₼ ☆ छ
Eile	<u>E</u> dit	<u>V</u> iew	F <u>a</u> vorites <u>T</u> ools <u>H</u> e	lp									
		Micr	osoft Azure 🛛 🗸								AZURE user ID:	>	· ·
			ALL ITEMS		virtı	ual mac	hines						
		\otimes	WEB SITES 0		INSTAN	CES IMAGE	S DISKS						
			VIRTUAL MACHINES		NAME		↑ STATUS		SUBSCRIPTION	LOCATION	DNS NAME	Q	
		¥	1		[Your	VM Name]	→ 🗸 Runni	na	Nutzungsbasierte Beza	hl West Europe	[VM DNS Name]		
		٢	MOBILE SERVICES										
		6 00	CLOUD SERVICES										
		DB	SQL DATABASES 0										
			STORAGE										
		(P)	HDINSIGHT 0										
		٢	MEDIA SERVICES										
		+	NEW	CON	K NECT	S RESTART	SHUT DOWN	<i>P</i> Attach	DETACH DISK		_Е 1 🗘	?	~

Step 1: Connect to the running virtual machine by clicking on the CONNECT-button

Step 2: Click on Open to launch the downloaded *.rdp file

The portal is retrieving the .rdp file. You will receive a prompt to open or save the file shortly.	ок ⊘
Do you want to open or save [Your VM Name].rdp (83 bytes) from manage.windowsazure.com?	Qpen ave Cancel ×

Step 3: Select the checkbox "Don't ask me again for connections to this computer" and press Connect

5	Re	mote Desktop Connection			
	The publisher of this remote connection can't be identified. Do you want to connect anyway?				
This remo where thi	ote connection could har s connection came from	m your local or remote computer. Do not connect unless you know or have used it before.			
	Publisher:	Unknown publisher			
-00	Туре:	Remote Desktop Connection			
	Remote computer:	[VM DNS Name]			
✓ Don't ask me again for connections to this computer ✓ Show Details					

Step 4: Enter the user credentials of the virtual machine as defined, when the VM was created

Here the user credentials need to be used that you have entered during Step 5 in chapter 3.2.3.

Windows Security	×
Enter your credentials These credentials will be used to connect to [Your VM DNS name]	
[Your VM user name]	
Domain: MicrosoftAccount	
Remember my credentials	
OK Can	cel

Step 5: Confirm that you trust the remote computer

5	Remote Desktop Connection
	The identity of the remote computer cannot be verified. Do you want to connect anyway?
The re securi	emote computer could not be authenticated due to problems with its ty certificate. It may be unsafe to proceed.
-Cert	Name in the certificate from the remote computer: [Your VM name]
Cert The con	ificate errors e following errors were encountered while validating the remote nputer's certificate: The certificate is not from a trusted certifying authority.
Do yo Do You Vier	u want to connect despite these certificate errors? ont tisk me again for connections to this computer w certificate <u>Y</u> es <u>N</u> o

Step 6: At the end you see the Azure desktop of the virtual machine:

	Server Manager				
	File Action View Help				
Recycle Bin					
	Server Manager	Server Manager			
	Acles Configuration Storage	Get an overview of the status of this server, perform to	op management tasks, and add or remove server roles and features.		
		Server Summary	Server Summary Help	- i	
		Computer Information Full Computer Name: Domain: Remote Desktop: Server Manager Remote Managerment: Product ID: Do not show me this console at logon			
		Security Information	😭 Go to Windows Firewall		
		Windows Firewall:	Configure Updates		
		Windows Updates:	** Check for New Roles		
		Last checked for undates:	Run Security Configuration Wizard		
		Lact installed undates:			
		IE Enhanced Security Configuration (ESC):			
		🔿 Roles Summary	👔 Roles Summary Help		
	I	S Collecting Data			
🈂 Start	2				DE

Step 1: Figure out and note the port needed for the remote desktop connection

Navigate to the following page on the Azure Management site by clicking on *VIRTUAL MACHINES* -> [your VM] -> *ENDPOINTS*. Note the *PUBLIC PORT* for Remote Desktop connectivity:

2	https://manage.windo	wsazure Q 🛪 🖨 C 📑 Virtual machiner - Window	×	- □ <mark>×</mark> ☆ ☆ ☆ :
<u>F</u> ile	Edit <u>V</u> iew F <u>a</u> vorites <u>T</u> ools			
	Microsoft Azure 🛛 🗸			🌐 <azure id="" user=""></azure>
		[Your VM name]		
	\otimes	42 DASHBOARD MONITOR ENDPOIN	NTS CONFIGURE	
	[Your VM name]	NAME	PUBLIC PORT PRIVATE PO	RT LOAD-BALANCED
		FlightZoomer UDP	57778 57778	
		PowerShell TCP	5986 5986	
	<u>@</u>	Remote Desktop TCP	52278 3389	
	DB			
	1999 - 19			
	• New	ADD EDIT	MANAGE ACL DELETE	?

Step 2: Install the free app REMOTE DESKTOP from the Store and start it



Step 3: Press on the + button to create a new connection as follows

Enter the VM DNS name and the noted port from step 1 into the PC name textbox, separated by a colon. Save the connection afterwards.



Step 4: After that connect to the server



Step 5: Et voila, there is your relay server, accessed from the phone



3.2.10 Shutdown the VM after usage to minimize charges

This step is only needed for:



In order to avoid charges don't forget to shut down the virtual machine after the work is done:

+ ttps://manage.windowsazure.com	/《 り ー 🔒 C 📲 Virtual machines - Window 🗙			- ⊔ ×
<u>File Edit V</u> rew F <u>a</u> vorites <u>T</u> ools <u>H</u> elp Microsoft Azure ~			AZURE user ID>	A ^
ALL ITEMS	virtual machines			
	INSTANCES IMAGES DISKS			
VIRTUAL MACHINES	NAME 🕆 STATUS	SUBSCRIPTION LOCATION	DNS NAME	
MOBILE SERVICES	[Your VM Name] → ✓ Running	Nutzungsbasierte Bezahl West Europe	[VM DNS Name]	·
DB SQL DATABASES				
STORAGE 0				
	CONNECT RESTART SHUT DOWN ATTACH			v

3.3 Prepare the FlightZoomer Sensorics-app

3.3.1 Attach the sensor smartphone

This chapter explains how the sensor smartphone needs to be mounted on an RC aircraft or copter. There are some things that need to be considered, some things that don't need to be considered and some things that depend on user preferences.

To be considered:

- The smartphone needs to be mounted detachable (in order to remove the device for compass calibration).
- Provide lightweight, yet sturdy installation.
- Provide as much clearance as possible to other electrical components.
- The smartphone needs to stay in a fix relative attitude vs. the aircraft/copter.

Not to be considered:

- The actual attitude of the smartphone relative to the aircraft/copter.
- It is not necessarily required that the touchscreen of the smartphone is accessible while the device is attached.

Dependent factors:

- If you intent to use the camera of the smartphone to create inflight footage or images stick to these guidelines:
 - \circ $\;$ The smartphone needs to be fitted with unobstructed camera vision.
 - Keep vibrations away from the smartphone. Google "copter" and "vibrations".

3.3.1.1 Best practices

The following images show some solutions how smartphones have been successfully attached to multicopters.

A very successful approach was to fix only the back cover of the phone, so the phone itself could easily be detached from the copter:



Another example where the back cover is fixed on the copter and the phone itself is just clipped onto the back cover:



The first two designs are not suitable to use the camera of the phone. The next two design have a frontmounted phone which allows using the camera:





Another design:



3.3.2 Install the app

The FlightZoomer Sensorics app can easily be loaded on any device from the store. Just enter "flightzoomer sensorics" in the search textbox.

3.3.3 Install and configure MAVLink connectivity

In order to mate sensor smartphone to the Ardupilot based flight controller a HC-06 Bluetooth transceiver needs to be used. This device can be purchased from 3DR or in many other online shops (e.g. on Ebay).

The following steps are needed to accomplish MAVLink connectivity between the flight controller and the onboard smartphone:

Step 1: Configure the Bluetooth transceiver to the recommended baud rate of 57600

While the 3DR device comes already configured at 57600 baud, other HC-06 devices typically have the default baud rate of 9600. As 9600 is not enough for the recommended MAVLink packet update rates, it is recommended to change the configuration of the transceiver accordingly.

For this purpose the Relay Server application has a special utility to automatically overwrite the configuration parameters of a HC-06 Bluetooth transceiver with the correct values:

Bluetooth Configuration Utility	x		
For the connection between the ardupilot flight controller an the FlightZoomer sensor device any HC-06 Bluetooth RF Transceiver can be purchased.			
These devices usually ship with a baud rate of 9600 which is enough for basic operation but not enough to exchange the full set required MAVLink messages at the recommended speed.			
Using this dialog you can program any connected HC-06 with a baud rate of 57600 and in addition overwrite its default name to 'MAVLINKnnnn_s' where 'nnnn' is an arbitrary four digit number and 's' is an optional suffix which can be set by the user (this allows to distinguish multiple paired devices).			
Before you can start the programing connect the device to this computer (e.g. via a USB to UART Converter) and select the assigned COM port below. Then click on the 'Program device'-button			
Port: COM5 V Status: Baud rate determined: 9600			
Program device with			
- Optional suffix to the name:			
- A user defined PIN (optional, default 1234):			
- A baud rate of 57600 -			

Perform the following actions to re-program the HC-06 device:

- Connect the HC-06 with the computer using a typical USB to RS 232/UART Adapter (as offered for Arduino) like shown on this image:



- Open the Bluetooth programming utility from the Relay Server main window by clicking the button *Bluetooth Configuration Utility...*.
- Confirm that the correct COM port is shown in the *Port* dropdown box (or select it otherwise).
- The current baud rate will automatically be determined!
- Choose whether you want to add a one-character-suffix to the name and choose a PIN code (or leave it at 1234).
- Click on the button *Program device with...*
- Once all steps are completed the utility looks like this:

Bluetooth Configuration Utility	×			
For the connection between the ardupilot flight controller an the FlightZoomer sensor device any HC-06 Bluetooth RF Transceiver can be purchased.				
These devices usually ship with a baud rate of 9600 which is enough for basic operation enough to exchange the full set required MAVLink messages at the recommended spe-	n but not ed.			
Using this dialog you can program any connected HC-06 with a baud rate of 57600 and overwrite its default name to 'MAVLINKnnnn_s' where 'nnnn' is an arbitrary four digit nu 's' is an optional suffix which can be set by the user (this allows to distinguish multiple pa devices).	d in addition mber and aired			
Before you can start the programing connect the device to this computer (e.g. via a US Converter) and select the assigned COM port below. Then click on the 'Program device	B to UART 9'-button			
Port: COM5 V Status: Programming finished!				
Program device with				
- Optional suffix to the name: 2 done! (MAV	LINK8119_2)			
- A user defined PIN (optional, default 1234): done!				
- A baud rate of 57600 done!				

Step 2: Connect the Bluetooth transceiver to the flight controller

For this step the documentation of the flight controller needs to be consulted. The following wiki page shows the connection for the APM and the PIXHAWK:

http://copter.ardupilot.com/wiki/common-optional-hardware/common-telemetry-landingpage/commonmission-planner-bluetooth-connectivity/

For the Arsov AUAV X2 the Bluetooth transceiver needs to be connected with the USART3 (SERIAL2) on the front side. The following diagram shows the respective pins. Always connect the Rx pin on one side of the connection with the Tx pin on the other side (and vice versa):



Step 3: Pair a new Bluetooth transceiver with the phone

This steps needs only to be done once for each particular HC-06 Bluetooth transceiver:

- 1. Power up the new transceiver until the red LED blinks.
- 2. On the phone open the *Settings > Bluetooth* screen.
- 3. Turn Bluetooth on if not yet done.
- 4. Select the new device in the list (identify the device with the name as generated in step 1 above) and press *tap to pair*:



5. Enter the PIN as also defined in Step 1 above:

Enter your 1234	Enter your PIN to connect. 1234				
dc	done cancel				
Bluetooth devices and be discoverable.					
1	2 авс	3 DEF	×		
4 GHI	5 jkl	6 мло			
7 PQRS	8 TUV	9 wxyz	_		
*	0 +	#	•		

6. Finished! From now everything can be done in the app.

Step 4: Configure the flight controller to feed the required MAVLink packets

As the last step the flight controller needs to configured to stream the required packets at the recommended rate.

Consult the functional aspects document to understand the exact set of packets which are needed.

Use the Ardupilot Mission Planner to set the SRx-parameters rates as follows (x stands for the chosen serial port):



Also set the baud rate of the serial port which feeds the Bluetooth transceiver to 57600 and the protocol to '1' (GCS MAVLink):



Step 5: Test the configuration

Run the FlightZoomer Sensorics-app and the flight controller. Mate the app with flight controller and check whether the MAVLink Status LED turns solid green after some time.

Also consult the raw data screen, to check the rate of the received MAVLink packets:



The first two lines show how many relevant packets have been received in the last second. The legend shows the order of listed packets and needs to be decoded as follows:

HB = HEARTBEAT/SST = SYS_STATUS/GPS = GPS_RAW_INT/IMU = RAW_IMU/ATT = ATTITUDE/ POS = GLOBAL_POSITION_INT/RCI = RC_CHANNELS_RAW/RCO = SERVO_OUTPUT_RAW

3.3.4 Prepare the app

Once the device is fitted to the aircraft/copter and the app is loaded on the device, the initial setup can take place. The initial setup is very easy and consists of these three steps:

- 1. Configure the relay server.
- 2. Configure the MAVLink connection to the flight controller (see the chapter before)
- 3. Geometry capturing. With this step the actual attitude of the device relative to the aircraft is measured.
- 4. Optionally choose options for the inflight camera (default = off).

3.4 Prepare the FlightZoomer Groundstation-app

3.4.1 Attach the device to the RC transmitter (optional)

While it is possible to keep the groundstation device loosely it is much more convenient, if the device is attached to the RC transmitter, so you have enough "hands" to hold everything properly.

A good and proved solution would be to buy a cheap case for the device and attach the case to the handle of the RC transmitter. Be inspired by the following images!



3.4.2 Install the app

The FlightZoomer Sensorics app can easily be loaded on any device from the store. Just enter "flightzoomer groundstation" in the search textbox.

3.4.3 Prepare the app

The preparation for the groundstation is even simpler than for the sensor device and has only one step:

- 1. Configure the relay. This is done exactly the same way as for the Sensorics-app.
- 2. Additionally the standard turn rates can be configured. Alternatively these they can be gained by the flight test feature (the system measures the turn rate automatically while steady turns are flown by the (test-)pilot...

3.5 Prepare the RC system

While it is possible to use with FlightZoomer with a regular RC system without modification, the flying experience and the realism can be greatly enhanced if the RC transmitter is configured adequately to simulate the behavior and autoflight systems of real aircraft.

As FlightZoomer is modeled after the Boeing 787 Dreamliner, let's first have a look at the original Boeing documentation, which explains the autopilot of the mighty 787. The following extract shows the glareshield panel of the autopilot:

Automatic Fight	
Controls and Indicators	Section 1
Mode Control Panel (MCP)	
А/Т АВИ 145() МАСН НОС () ТИК	V/5()FPA ALTITUDE
	× [™] +2000 17000 [™] → 12000
GLARESHIELD	PANEL
Autopilot Flight Director System Co	ontrols

The panel looks rather complicated but the meaning of each control is quite understandable if we dig a bit deeper in the next chapters.

3.5.1 Speed hold/autothrottle mode

The following extract from the original manual explains in detail the controls of the autothrottle and speed controls (IAS/MACH = the two speed modes):



The autothrottle can work in several ways but the simplest mode is the speed (SPD) mode. In this mode the desired target speed is dialed in using the IAS/MACH Selector (Nr. 3 in the middle image, the value is shown in display Nr. 2). Pressing the A/T switch (Nr. 3 in the left image) the autothrottle starts controlling precisely the thrust to maintain the target speed.

This procedure currently can't be simulated with FlightZoomer but a similar behavior can be achieved by configuring the RC transmitter as follows (using a multicopter):

By mixing a configurable proportional control to the pitch channel, constant pitch-angles can be applied (while the channel's stick stays untouched). At a constant tilt angle, a multicopter will establish a constant speed (wind effects aside). So a certain target speed can be set by turning that control until the reported speed matches the desired target speed.

3.5.2 Constant turn mode

Another possibility which greatly improves the usability and the precision of FlightZoomer operations is the provision of constant turn rates by configuring the RC system accordingly. FlightZoomer uses a constant value as the expected turn rate for the calculation of turn radiuses, route length & duration and the turn countdown timer. The expected turn rate can either be set manually or measured automatically with the flight test feature. This behavior again matches real aircraft like the Boeing 787 Dreamliner which also have a standard 3°/second turn rate.

As a constant and consistent turn rate is hard to achieve manually (with the yaw/rudder channel) it is recommended to implement this capability also with the RC transmitter (this again makes only sense using a multicopter).

There are two recommended ways to achieve that:

 By mixing two configurable switches (ideally spring loaded) to the rudder channel, constant turn rates can be commanded (while the channel's stick stays untouched). For a typical multicopter this might require to mix +10% to the yaw channel if the turn-right-switch is actuated and -10% if the turn-leftswitch is actuated. A turn rate of about 6°/second proved to be quite good for RC modeling purposes.

Or alternatively:

2. Use the dual rate feature to have either the full travel or only +/- 10%. The second, reduced control travel will be used for constant, gentle turns and shall be made available by an external switch. This way the normal rudder stick can be used.

3.5.3 Example

The following image shows a solution how a RC transmitter has successfully been configured to support constant speed and constant turn rates operations with multicopters:



3.6 Prepare the navigation database

One important step for preparing FlightZoomer is the creation of a suitable navigation database. This task is done with the Relay Server application as described between in the functional aspects document.

Some tips how to setup the navigation database:

- Creating the navigation database means that you already have a clear vision what kind of flights you want to do.
- Wherever you wish to have waypoints for your routes place a VOR or a GPS FIX. You can cover the whole landscape with as many navigation aids as you want.
- Place airports that real (rural) roads are aligned with the runway. You don't need real landing strips, especially with multicopters. This means that you can defined touchdown points virtually everywhere (the reason is that the accuracy realistically anyway does not permit, to land actually solely based on the FlightZoomer ILS).
- One airport typically is enough because RC aircrafts usually land where they took off!

4 Appendix

4.1 Glossary

Abbreviation/term	Description	Real aviation term
FMS	Flight Management System	Х
ILS	Instrument Landing System	Х
IM	Inner Marker	Х
LNAV	Lateral Navigation Auto flight mode where the loaded flightplan is being followed.	x
MM	Middle Marker	Х
ND	Navigation Display	Х
OM	Outer Marker	Х
PFD	Primary Flight Display	Х
VOR	VHF omnidirectional range	Х