SPH ENGINEERING
SMART PLANES & HELICOPTERS

UgCS DDC

Version 3.0

User Manual

SPH ENGINEERING
DZIRNAVU IELA 62-9, RIGA
LV-1050, LATVIA

PH: +371 25453422
PH: +1 650 681 9755
E-MAIL.: UGCS@UGCS.COM

UGCS.COM/DDC
SPH-ENGINEERING.COM

Table of Contents

Overview

DDC 3.0 group flights are based on animations which are then converted to special .PATH files. Flight process is time-synchronized (with GPS time used) and runs autonomously. To ensure the dance functionality, the process utilizes special flight controller firmware featuring a custom Dance flight mode.

This section provides an insight into the Dance process operation and requirements.

Drawing and converting dance paths

The way vehicles will fly and light up during their dance is first defined by the animation software used, for example, Blender. In essence, each vehicle is represented by a dot in an animation, with dot locations described by 3-dimensional coordinates convertible to geographic locations in physical space. Vehicle lights may be either defined in an animation or controlled separately.

When preparing an animation, make sure that vehicle trajectories do not cross each other and that distances between all vehicles are safe at all times. After the animation is ready, it must be checked for collisions using our script and then converted to special .PATH files containing actual flight trajectories and color settings.

Adapting dance paths to specific locations and requirements

When a compatible animation is ready, it may be modified to increase distance between vehicles if required. After the .PATH files are generated, an operator may specify the animation speed from 4 frames per second (typical) to 1 frame per second resulting in a longer, but less smooth flight.

Before running the show, an operator must define center coordinates, azimuth, and start time after the vehicles take off. This is done in **UgCS DDC.**

Running the dance and dance specifics

To run a UgCS DDC 2.0 dance show, operator must follow these steps:

1. PLACEMENT:
    a. Place vehicles in correct formation on the ground and ensure their positions are firm and steady.
2. UPLOAD PATH:
    a. Upload paths to the vehicles and check if all vehicles have rebooted.
3. SPECIFY DANCE CENTER, HEADING, AND FENCE:

   a. Specify and upload correct dance formation center, heading, and fence.

4. CHECK START OFFSETS:
   a. Check that horizontal and vertical start offsets are within safe limits for all vehicles.
5. ARM VEHICLES.
6. SET AND UPLOAD TIME:
   a. Set and upload the dance start time.
7. START THE DANCE:
   a. Until the set time reaches 20 seconds to start, click Dance and watch the show.
8. LAND:
   a. When the show is over, land the vehicles.

Dance mode

To perform time-synchronized flights, SPH Engineering have developed custom flight controller firmware supporting a special Dance mode.

Unlike standard Auto mode, in Dance mode, a vehicle moves along a predefined trajectory described by a function of time in the 3D space. The Dance trajectory may be described as a list of points separated by a specific constant time. Each point has local XYZ coordinates and RGB color value. The trajectory length may be up to 1,000 points. A usual flight speed is 4 points per second, yielding maximum flight time about 4 minutes. The flight time may be increased by reducing the number of points per second.

Dance mode also allows for setting the exact flight start time. Thus, an operator can create consistent trajectories for any number of vehicles with their synchronous start and flight using GPS time as a reference.

UgCS DDC installation

In order to start using **UgCS Drone Dance Controller (DDC)** it is first necessary to install and configure it properly.

There are no specific settings that should be changed during the installation. Although you may install only those components that will be used on a specific computer (a multi-node installation),

you are strongly encouraged to install all components, since they need a little disk space and can be used to replace any other computer in emergency.

If you want UCS Server (for map and mission data storage, routing, and mission calculation) to automatically run when a computer starts or configure advanced settings, then select the following settings during **UgCS DDC** installation:

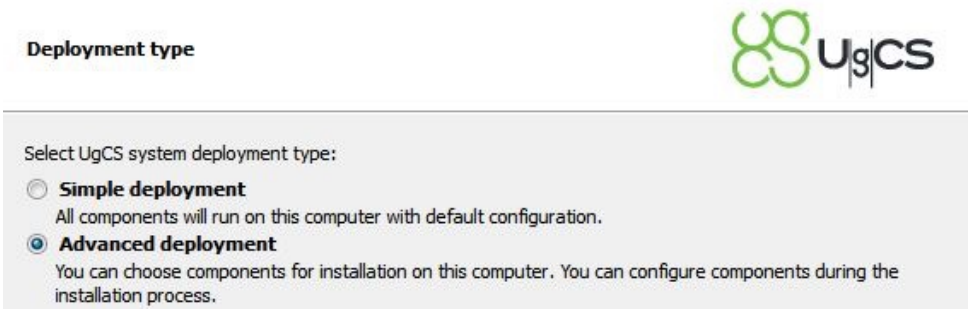

Figure 1. Select 'Advanced deployment' to automatically run UCS Server after Windows start

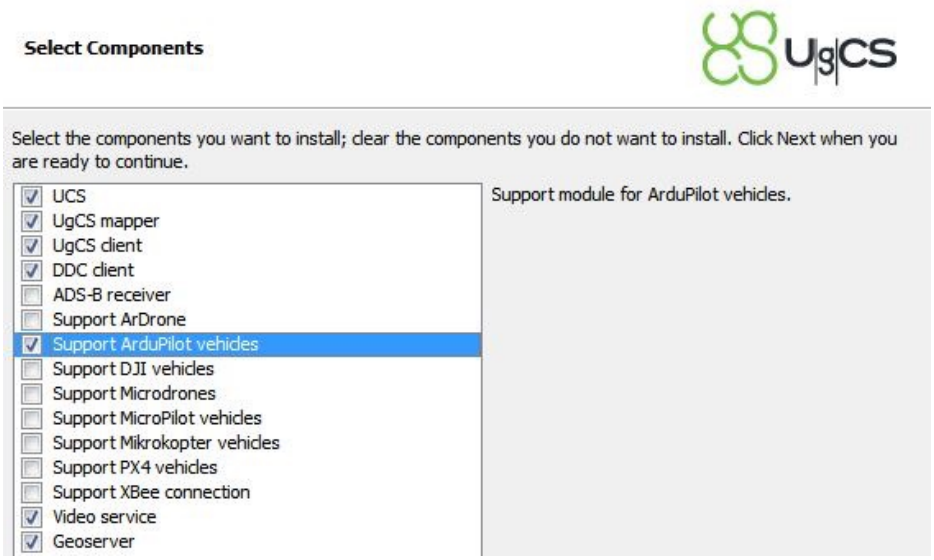

Figure 2. Selecting components for installation

To start when the computer starts, **UgCS** Server, Pixhawk/APM Vehicle Specific Module (VSM), and Geoserver (used for custom map overlay and elevation data) should be installed as system services.

You may also specify additional connection parameters during the installation, but they are meant for Virtual COM port communication configuration and not for TCP/UDP configuration.

UgCS DDC configuration and deployment

This section explains how to set up **UgCS DDC** in a multi-node configuration.

For a multi-node deployment, the same **UgCS DDC** version should be installed on all computers in question. It is also desirable, but not required, to install all **UgCS DDC** components on all computers.

Moreover, it is recommended to have UCS Server and VSM running on one computer and **UgCS DDC** Client and **UgCS** Client running on other available computers.

NOTE: As a mandatory condition, all computers should have a network access to the computer running UCS Server and VSM.

Configuring UCS Server

A computer that will run UCS Server, VSM, and Geoserver, does not require running UgCS DDC Client and UgCS Client.

In order to configure other computers running UgCS DDC Client and UgCS Client, you need to know IP address of the computer running UCS Server and VSM. The easiest way to find it out is to run **ipconfig** command from Windows command prompt.

Computers running UgCS DDC Client and UgCS Client will connect to this IP address.

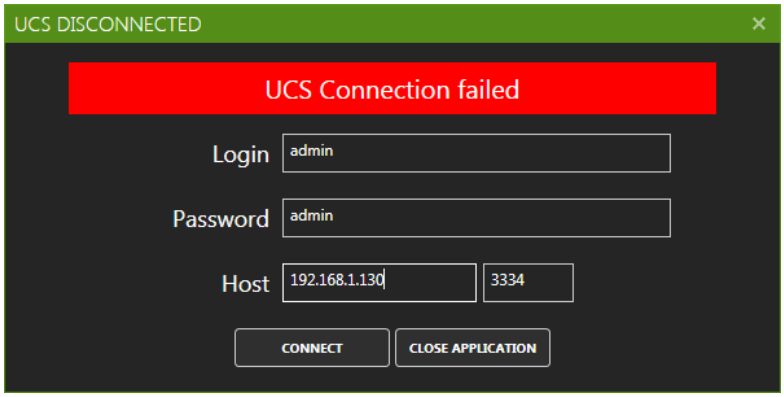

Figure 3. Entering user credentials and Server IP address

You are strongly recommended to change default login and password and create new Operator users to add another layer of security. To do so, open **UgCS** Client on the computer running UCS Server and go to Users tab in the Main Menu. At first, there is only one user: "admin" with password "admin". Change these credentials as desired and create new users with Operator role for the ease of use.

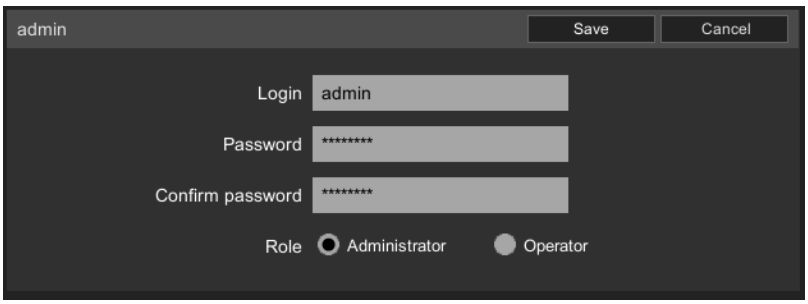

Figure 4. User login and password settings in Users tab in Main Menu (UgCS Client)

Configuring Vehicle Specific Module (VSM)

Vehicle Specific Module (VSM) is used to connect to the vehicle and governs advanced routing settings. To configure VSM, edit the vsm-ardupilot.conf file, which is typically located in *C:₩Program Files (x86)₩UgCS₩bin* or the installation directory you have specified.

Connection settings

To start connecting VSM to available vehicles over UDP, specify the ports VSM must listen for available devices (flight controllers).

Lines 36-38 of the vsm-ardupilot.conf file contain the following text:

```
# Vehicle can be connected via UDP
# UDP port which will listen for incoming mavlink messages
connection.udp_in.1.local_port = 14550
```

To configure vehicle connections, it is recommended to specify a unique local port for each vehicle.

An example configuration for three vehicles:

```
connection.udp_in.1.local_port = 14561
connection.udp_in.2.local_port = 14562
connection.udp_in.3.local_port = 14563
```

Notice how both port and vehicle number (1, 2, 3) are changing from line to line. Make sure to restart VSM after making any changes.

Regular GPS and RTK GPS related settings

The vsm-ardupilot.conf file contains two critical settings which govern how **UgCS** will calculate the altitude of a vehicle. By default, these settings are configured for use with regular GPS modules.

NOTE: If a vehicle fleet is equipped with RTK GPS setup and an RTK base station, these two lines in the vsm-ardupilot.conf file should be uncommented (the "#" character from the beginning of each line should be removed) and should look like this:

```
vehicle.ardupilot.report_relative_altitude = no

vehicle.ardupilot.set_ground_alt_offset = no
```

- Report relative altitude – means that ALT value from flight controller is not absolute.
- Set ground alt offset – means that a vehicle is on the ground surface level and AGL altitude during a path upload is zero.

Light control settings when a flight controller is used

If LED payloads connected to servo outputs on the flight controller are used, it is necessary to add the following lines to vsm-ardupilot.conf file.

```
# G

vehicle.ardupilot.parameter.SERVO9_FUNCTION = 82

# B

vehicle.ardupilot.parameter.SERVO10_FUNCTION = 83

# R

vehicle.ardupilot.parameter.SERVO11_FUNCTION = 81
```

Each line corresponds to a single color channel – green (G), blue (B) and red (R). The light channels need to be mapped because the servos are controlled from within the flight controller and not from UgCS or DDC Client.

Note: a fence will work in both Auto mode and all Manual modes. SET_SERVO will work when vehicles are on the ground. But when they are in Dance mode, SET_SERVO will be overridden by Dance RGB values. New BLINK function will work even when drones are dancing.

Time offset settings related to takeoff and moving to a dance position

Vehicles are intended to make autonomous takeoff and fly to their respective starting positions before the dance starts. To reduce potential chaos, we introduce two parameters:

```
# Takeoff time offset
```

```
vehicle.ardupilot.parameter.DANCE_TK_OFF = 60

# Moving to position time offset

vehicle.ardupilot.parameter.DANCE_MV_POS = 45
```

Both parameters mean time offset in seconds before the Dance start. DANCE_TK_OFF sets time offset for taking off. So if DANCE_TK_OFF = 60, vehicles will take off a minute before a dance start. DANCE_MV_POS sets time offset in seconds before moving to dance starting positions. So if DANCE_MV_POS = 45, vehicles will begin moving to their first trajectory points 45 seconds before a dance start.

In DDC client, these values are shown in the Start Time column.

Other routing settings

Another important routing setting that can be configured in the vsm-ardupilot.conf file is autoheading enabling/disabling. If autoheading is enabled, then a route will be created in such a way that a vehicle will always face the next trajectory point. If autoheading is disabled, the vehicle will not change its yaw angle unless changed by Yaw action for a respective waypoint. The autoheading behavior is controlled by the following line in the vsm-ardupilot.conf file:

```
vehicle.ardupilot.autoheading = no
```

Changing Arducopter parameter groups using the vsm-ardupilot.conf file

You can change one or more Ardupilot configuration parameters by modifying the vsm-ardupilot.conf file. The vsm-ardupilot.conf file contains one sample line which can be used as an example to configure other autopilot parameters. When parameters are added to this file, they are changed within Ardupilot when VSM connects to vehicles. For example, if you want to set action on RC loss = N/A thus disabling a respective fail-safe setting, add the following line to the vsm-ardupilot.conf file and restart Ardupilot VSM:

```
vehicle.ardupilot.parameter.FS_THR_ENABLE=0
```

Once vehicles have been discovered by VSM, you may remove the line from the configuration file.

Configuring UgCS DDC

To configure UgCS DDC, the file DDClient.exe.config needs to be edited. It is typically located in C:₩Program Files (x86)₩UgCS₩client-DDC directory. The following settings should be changed:

- Names of the vehicles used
- Fence radius, altitude, and polygon
- Vehicle groups

<add internalid="1" name="APM-101" defaultroute="1" supervisor="User 1" fenceradius="100" fencealtitude="120" polygonfence="false"/>

This is a sample line from the DDClient.exe.config file with vehicle settings.

Names of the vehicles used

Specify names of the vehicles that will be used, before vehicles are displayed in UgCS DDC. Default vehicle names in the DDClient.exe.config file are 1, 2, 3.., etc. (name="1", name="2", name="3",..). You may either set vehicle names for connected vehicles according to this rule in UgCS client or change the DDClient.exe.config file to match your connected vehicles.

Vehicle group settings

Groups are used to quickly access a certain drone subset in the DDC user interface. The grouping logic may depend on the drone start positions, number of operators to be controlled or formation specifics.

<groups>

<add internalid="1" name="Group-1" vehicles="1,2,3,4,5,6,7"/>

<add internalid="2" name="Group-2" vehicles="8,9,10,11,12,13, 14"/>

<add internalid="3" name="Group-3" vehicles="15,16,17,18,19,20"/>

</groups>

This sample illustrates how 20 vehicles can be grouped and controlled by three operators. One vehicle may have multiple operators (two operators may control the same vehicle), and new groups may be added by creating a new line in the same format, for example:

<add internalid="4" name="Group-4" vehicles="7, 10, 14, 19"/>

NB: If several DDC clients are used, each of the nodes should be configured.

Safety settings and precautions

Fence settings

Setting up a fence helps prevent vehicles from flying outside a defined area. You may set a fence in two ways: either define fence parameters for each vehicle in the DDCClient.exe.config file or use the vsm-ardupiot.config file. Setting a fence in DDC Client allows for better accuracy and individual settings for each vehicle.

Note: A fence is calculated from the vehicle start point (Home Location). You should set the fence in either DDCClient.exe.config file or vsm-ardupilot.config file. Never use both options at once.

Fence radius, altitude and polygon in the DDCClient.exe.config file

A fence may be cylindrical and/or polygonal.

A cylindrical fence is the main fence type. You may use it either separately or together with a polygonal fence. By changing fenceradius and fencealtitude parameters, you may define specific flight restrictions for each vehicle. These parameters are defined in meters from the start point (Home Location) **H** as shown in Figure 5. The action to be performed by a vehicle after breaching the fence may be specified in Mission Planner.

In addition to a cylindrical fence, you may define a polygonal fence by setting polygonfence parameter to "true". When a polygonal fence is used together with a cylindrical fence, a fence is deemed breached when a vehicle crosses either cylindrical fence or polygonal fence border. If both fence types are used, the permitted flight area is where cylindrical fence and polygonal fence overlap as shown in Figure 5. In order to restrict the permitted flight area by a polygonal fence only, the cylindrical fence should be large enough to fully cover the intended polygon.

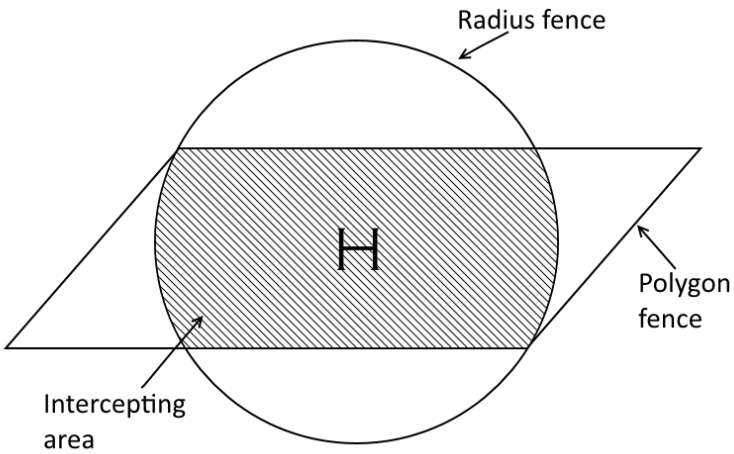

Figure 5. Permitted flight area within a fence

To setup a polygonal fence, make several steps. First, create a new route in UgCS Client and mark the desired fence area using Perimeter tool  in UgCS. When the area is marked, export the route as an *.XML file and open the file in a text editor. The lines you need should look like this:

<ugcs-List name="points" type="FigurePoint" v0="id" v1="version" v2="order" v3="latitude" v4="longitude" v5="wgs84Altitude" v6="aglAltitude" v7="altitudeType">

<o v2="0" v3="0.5900877312384658" v4="-1.4685816967389724" v6="0.0" v7="AGL"/>

<o v2="1" v3="0.5900910492826061" v4="-1.4685958825188987" v6="0.0" v7="AGL"/>

<o v2="2" v3="0.5900957350709617" v4="-1.4685953519569892" v6="0.0" v7="AGL"/>

<o v2="3" v3="0.5900981341526812" v4="-1.468586617752834" v6="0.0" v7="AGL"/>

</ugcs-List>

Then, edit the DDClient.exe.config file and paste these lines within <polyfence> </polyfence> tags. Save the changes and restart DDC Client for the changes to take effect.

Note: a fence will work in both the Dance mode and all Manual modes.

Fence settings in the vsm-ardupilot.conf file

You may also set a fence using VSM parameters. A fence will be applied as soon as a vehicle is connected to VSM. Typical parameters include:

vehicle.ardupilot.parameter.RTL_ALT = 600

-Altitude (in centimeters) at which a vehicle will return to the Home Location

vehicle.ardupilot.parameter.RTL_ALT_FINAL = 600

- Altitude at which Return Home operation will be finished (if set to 0, vehicle will land)

vehicle.ardupilot.parameter.FENCE_ACTION = 1

-If a fence action is set to "1", a vehicle will return to the Home Location in case of fence breach

vehicle.ardupilot.parameter.FENCE_ALT_MAX = 15

-Maximum fence altitude in meters (from the Home Location)

vehicle.ardupilot.parameter.FENCE_RADIUS = 20

-Maximum fence radius in meters (from the Home Location)

vehicle.ardupilot.parameter.FENCE_ENABLE = 1

-If set to "1", a fence is enabled

vehicle.ardupilot.parameter.FENCE_TYPE = 3

-Fence type 3 means that a fence is limited in radius and altitude

UgCS Client and UgCS DDC Client show operation guide

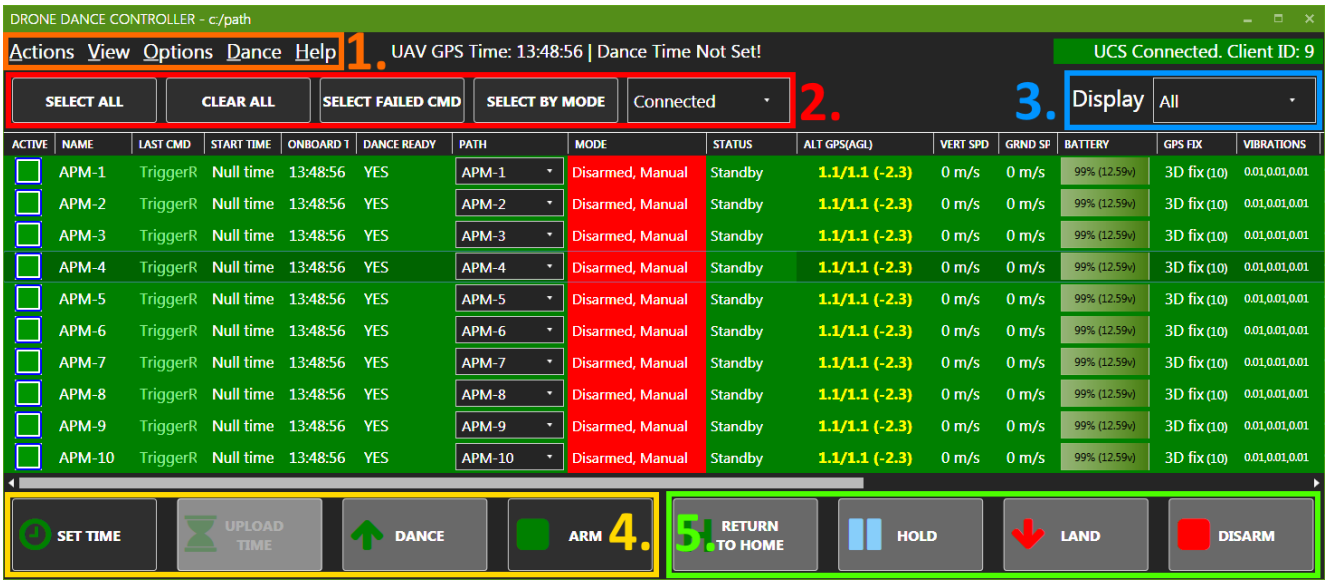

Figure 6. DDC Client main view with marked control areas

The UgCS DDC Client has six main control areas and a spreadsheet-like list of vehicles. Each area is for a specific purpose.

Actions/View/Options/Dance/Help area ("1" in Figure 6)

The Actions tab supports the following commands:

- Reload Vehicle list – refreshes the vehicle list and checks for any changes.
- Load new dance – opens a context menu to select the dance PATH file folder.

- Set TO point altitude – sets a take-off altitude to level all vehicles above the ground (entirely informative).
- Turn off the lights – as the name implies, turns off vehicle LED lights (if controlled by flight controller).
- Blink UAVs – lights up the LED payload for two short periods (all colors).
- Set servo – sets a specific PWM signal on the selected servo. This may be used to change the color to check that all color channels are working or initiate fireworks
- Manual mode – switches the selected vehicles to the Manual mode.
- Adjust last point – sets the last route point of the selected vehicles to current vehicle location.
- Upload settings – opens a dialog allowing you to upload *.PARAM file with flight controller parameters.
- Reboot vehicles – restarts the flight controller on selected vehicles to re-initialize all sensors.
- Exit – closes this menu.

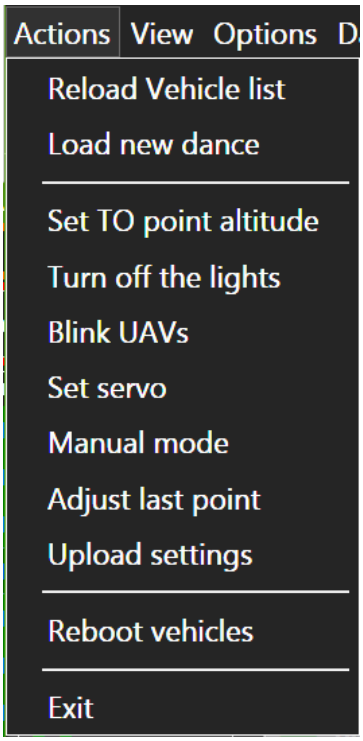

Figure 7. The Actions tab

In the View tab, the View server logs button displays a window with UCS Server log messages.

In the Options tab, the General options button opens a window with the following controls:

- Arm confirm – enables or disables confirmation message before executing Arm command; the same meaning is for Disarm, Hold, Land, Return to home, Reboot, and Set servo commands.
- Arm interval – specifies the time in seconds after which Arm command is actually sent to the vehicles; the same meaning is for Disarm, Hold, Land, and Return to home commands.
- Blink color Value [0-255] – sets the intensity of each color (Blue, Green, and Red) during Blink action.
- Blink rate [Hz] – sets the frequency of Blink action.
- Blink time (millisecond) – sets the duration of Blink action in milliseconds.
- Dance Center AMSL – defines the altitude at which the dance will be performed (meters, AMSL).
- Dance center Heading – defines the angle to the North at which the dance will be performed (degrees).
- Dance center Latitude/Longitude – defines Dance center latitude and longitude.
- Dance Max Altitude to First Point (meters) – sets the maximum safe altitude from a take-off point to the first point (informative).
- Dance Max Distance to First Point (meters) – sets the maximum safe distance from a take-off point to the first point (informative).
- Dance Min Altitude to First Point (meters) – sets the minimum safe altitude from a take-off point to the first point (informative).
- Dance Start Interval (in seconds) – sets the time offset (will be added to current GPS time) in seconds after which the dance will be performed.
- Default timeout for command – timeout after which a command will be regarded as non-executed or failed.
- Execute hold before RTL – enables or disables executing Hold command by UgCS DDC before Return to Home command.
- Host – sets the host IP address to connect to (UCS Server).
- Login – sets the login username.
- Measurement - switches between Imperial or Metric measurement systems.
- Password – allows for the changing of a user password.

- Port - allows for the changing of a connection port.
- Vibration threshold XY, Vibration threshold Z – sets maximum vibration levels for respective axes (informative).

In the Help tab, Support and Contacts buttons lead to respective UgCS website pages.

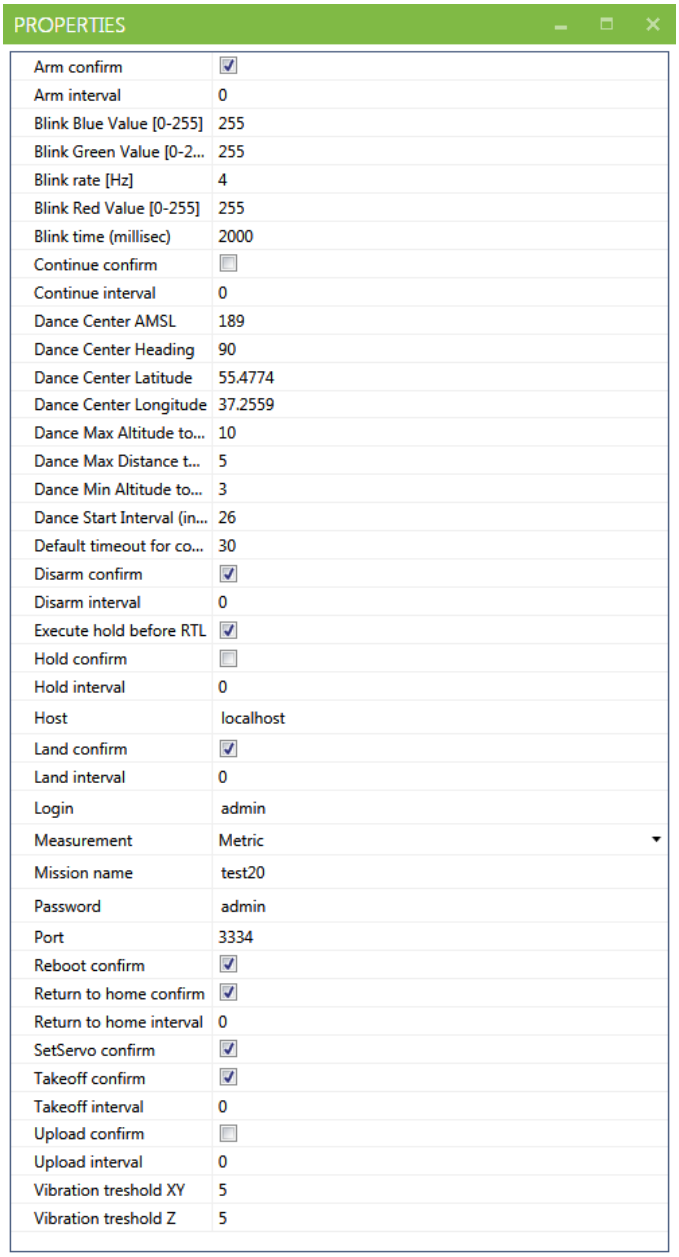

Figure 8. General options window with available controls

The Dance tab (upload commands)

The Dance tab is used to upload a path and fence. It supports the following commands:

- Upload Path – uploads the selected ɜath to a vehicle.
- Upload Location – uploads the location (Dance Center) set in the Options tab, to a vehicle.

- Upload Fence – uploads the fence settings from the DDCClient.exe.config file.

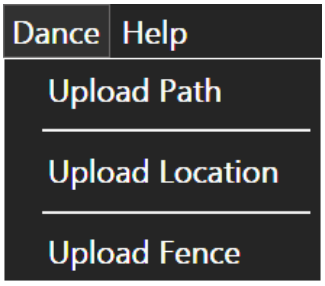

Figure 9. The Dance tab with available controls

Vehicle selection area ("2" in Figure 6)

The vehicle selection area supports the following commands:

- Select All - selects all vehicles.
- Clear All – unselects all selected vehicles.
- Select Failed CMD – selects only the vehicles, which failed to execute the last command.
- Select by Mode – selects the vehicles with a specified status. There are four statuses for selection:
    - Connected
    - Disconnected
    - Disarmed
    - Armed

Filter by Operator or status area ("3" in Figure 6)

The Filter by Operator or status area allows operator to instantly show only the vehicles with the status chosen in this area. The following options are available:

- All – displays all vehicles.
- Armed – displays only armed vehicles.
- Disarmed – displays only disarmed vehicles.

Group – by default, there are three groups to be used by various operators for displaying only the vehicles needed. New groups may also be added.

Dance start commands

The following commands are available in the dance start area ("4" in Figuree 6):

- SET TIME – adds the specified start time from the General Options menu to a current vehicle time (sets the beginning of show).
- UPLOAD TIME – uploads the specified start time to vehicles.
- DANCE – sets the vehicles to Dance mode (starts the flight).
- ARM – arms the motors (should be executed before Set Time, Upload Time, and Dance commands).

Dance end commands

Commands in this area ("5" in Figure 6) are used to end a dance.

- Return Home – instructs a vehicle to reach preset Return Home altitude and Return Home location.
- Hold – pauses a flight and instructs a vehicle to hover in its current position.
- Land – executes a landing algorithm: a vehicle lands in its current position.
- Disarm – disarms motors.

Columns

Last Cmd Column

Displays last command name that was send to a vehicle (green if a command was successful and red if not).

Start Time Column

Displays absolute dance start time (UTC) and time offsets. Start time column has the following format: HH:MM:SS (X/Y/Z) where:

- HH:MM:SS - absolute UTC dance start time.
- X - time left to a vehicle take-off (in seconds).
- Y - time left to a vehicle moving to a start position (in seconds).
- Z - time left to a vehicle dance start (in seconds).

Onboard Time Column

Displays current vehicle onboard time (UTC), which is taken from a GPS sensor.

Path Column

Allows for the manual selection of a vehicle path file. May be filled automatically by Assign Path command in Dance menu.

Mode Column

- Disarmed, Manual – a vehicle is ready for Arm and Dance.
- Armed, Manual – a vehicle is ready for Dance command and take-off.
- Armed, Auto, Flying to point – a vehicle is executing Dance.
- Armed, Auto, Landing – a vehicle is Landing.
- Disarmed, Auto, Landing – after the flight, a vehicle must be set to Manual mode (Actions/Manual mode) to execute the Dance again.

Vehicle status column

Displays current vehicle status. There are four statuses:

- Standby – a vehicle is ready for take-off.
- Airborne – a vehicle is currently airborne.
- Not ready – a vehicle is not ready for take-off yet.
- Critical – a vehicle battery is low or flight controller reports sensor problems.

Altitude column

Displays GPS altitude and altitude above the ground level. This column has the following format: X/Y (Z) where:

- X – a raw GPS altitude, obtained directly from a sensor.
- Y – a filtered GPS altitude.
- Z – an altitude above the ground level.

Speed columns

Vertical and Ground Speed columns display vehicle current speeds.

Battery column

Displays battery status in percents and volts. May be specified in **UgCS** client according to battery used.

GPS Fix column

The following GPS Fix statuses are possible:

- No Fix – GPS position not fixed, not ready for flight.
- 2D Fix – GPS position fixed in two dimensions, not ready for flight.

- 3D Fix – GPS position fixed in three dimensions, ready for flight if not using RTK GPS receiver.
- DGPS Fix - GPS position fixed in three dimensions with improved accuracy, ready for flight if not using RTK GPS receiver.
- RTK Float – RTK GPS position fixed with acceptable accuracy, ready for flight.
- RTK Fix – RTK GPS position fixed with perfect accuracy, ready for flight.

Vibrations column

Displays current vibrations of an autopilot. If the vibrations exceed threshold values then the text turns red.

Datalink column

Displays current datalink level. 100% means the best level and 0% means no datalink.

Path length column

Displays length of the path (trajectory) currently loaded to an autopilot memory, which length is measured by the number of trajectory points. Thus, a 160-point path will be covered in 40 seconds at four points per second (160 / 4 = 40).

Offset To Start column

Displays horizontal and vertical distances to the first trajectory point from the current vehicle location in meters. Useful for detection problems of mission location. When the values exceed threshold values, the column turns red.

Max Relative Alt column

Displays maximum relative altitude a vehicle will climb during the trajectory currently uploaded to it.

Max Distance from Center Column

Displays maximum distance from the dance center (not from current vehicle position!) a vehicle will flow away during the trajectory currently uploaded to it.

Max Horizontal & Vertical Speed columns

Display maximum horizontal and vertical speeds a vehicle will reach during the trajectory currently uploaded to it.

FPS column

Displays current FPS settings UAV will flow loaded path with. For example, a 160-point path with four points per second will be covered in 40 seconds (160 / 4 = 40). Reduce the number of points pes second to increase the flight duration and to decrease vehicle speed and vice versa.

Comm Method column

Displays current connection type and respective vehicle address.

Firmware column

Displays vehicle firmware hash.

Typical workflow

This section describes planning and holding a typical drone dance event. It introduces users to main functions and steps required to run a drone show with UgCS DDC.

Preparatory activities

When planning a show, you need an appropriate set of *.PATH files ready and tested. You should know the initial vehicle formation from which the dance will start and plan ahead the exact position each vehicle will take off from. All vehicles should be tested in flight individually prior to performing a group flight (dance).

Connecting vehicles and selecting paths

First, create a new Vehicle Group in the DDCCLient.exe.config file. This group should only contain the vehicles planned for the show. Next, when you open UgCS DDC for the first time, you will be asked for a folder containing the .PATH files for the show.

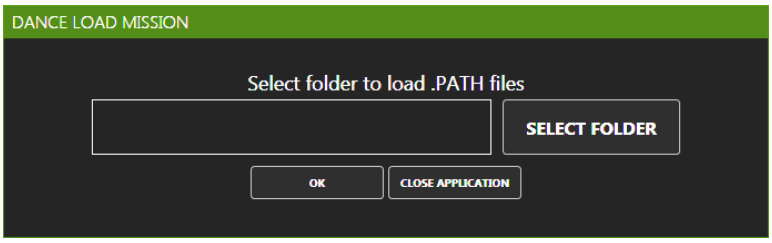

Figure 10. The .PATH file location selection dialog

Then, make sure that all the vehicles can be connected and are displayed both in UgCS client and UgCS DDC Client (a correct group should be selected). Read more about connection and Groups in the Configuring Vehicle Specific Module (VSM) and Configuring UgCS DDC sections.

Figure 11. Three properly connected vehicles in UgCS with good telemetry status of all sensors

If any vehicles do not appear in UgCS client, check if they are visible in the Uplink connected list under Menu/Vehicles/Uplink connected or look for the vehicles by clicking "+" next to connected vehicles in Figure 11.

After all involved vehicles have confirmed connection and display correct status both in UgCS and UgCS DDC, you may select the appropriate .PATH file for each vehicle.

Setting a Dance Center

Since .PATH files only contain coordinates relative to a position defined in an animation, you should specify a Dance Center using Latitude, Longitude and Altitude parameters.

To assess a Dance Center, the vehicles should be placed in their positions firmly and stably (GPS and ALT). Now, in **UgCS** client, you can see all the vehicles on a 3D Globe and by placing a single waypoint in the center of the formation (or different position depending on animation) and noting its coordinates and altitude a dance center can be set.

To make sure that the center and fence have been set correctly, follow these steps:

1. Select correct .PATH file for all vehicles.
2. Select all vehicles and click Dance/Upload Path.
3. Wait for the vehicles to initialize and Click Dance/Upload Location.
4. Click Dance/Upload Fence.

Flight lines (blue) from vehicle current locations to first points of the dance will be displayed in UgCS client, and the fence will be uploaded to the vehicles. The offsets can also be viewed in UgCS DDC in the vehicle list under OFFSET TO START. Using these methods, make sure that all vehicles are in correct positions and Dance Center is where intended. If any vehicles in UgCS client are displayed too low or too high over terrain, use the Set TO point altitude command in Actions tab to correct this.

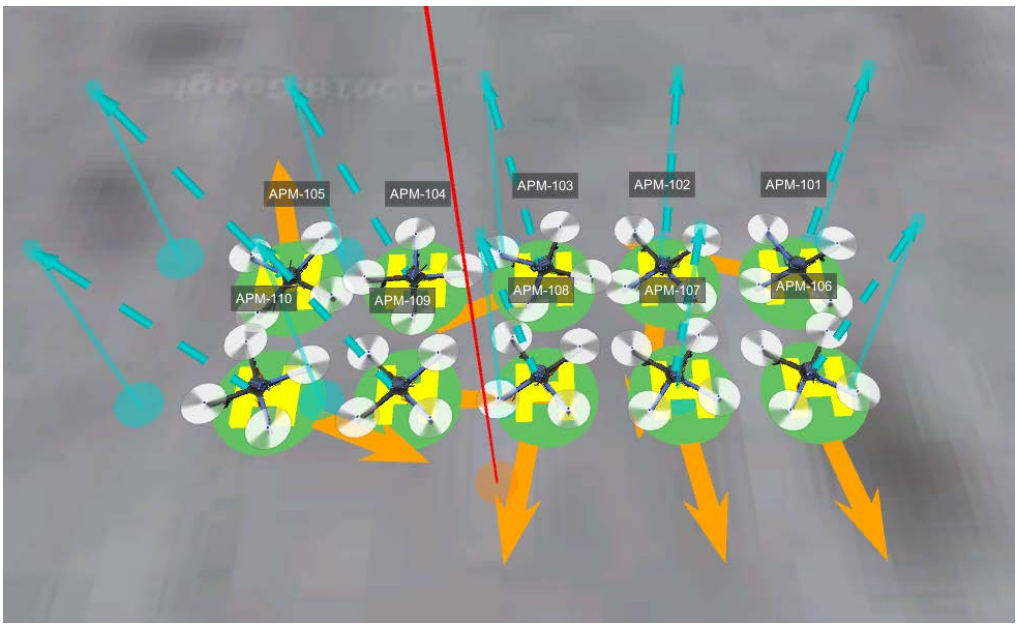

Figure 12. Connected vehicles in UgCS with flight lines to first points of the dance

Taking off and running the show

To view vehicle readiness for take-off, look at the Dance Ready column. It shows not-yet-completed actions with a red color. A vehicle will only be ready when all required steps are completed.

Note: Always keep in mind the steps taken and never rely solely on Dance Ready status. If in doubt, repeat all steps.

When the Paths and fence have been uploaded and Dance center has been set correctly, you may continue to the final dance step—uploading time and switching to the Dance mode.

ACTIVE	NAME	LAST CMD	START TIME	ONBOARD T	DANCE READY	PATH	MODE	STATUS	ALT GPS(AGL)	VERT SPD	GRND SPD	BATTERY
☑	APM-101	SetDanceLocat	00:00:00	12:02:47	NO (Size Center Time FPAlt Fence)	APM-101	Disarmed, Manual	Standby	1.0/1.0 (-2.6)	0 m/s	0.1 m/s	99% (12.59v)
☑	APM-102	SetDanceLocat	00:00:00	12:02:47	NO (Size Center Time FPAlt Fence)	APM-102	Disarmed, Manual	Standby	1.0/1.0 (-2.7)	0 m/s	0.1 m/s	99% (12.59v)
☑	APM-103	SetDanceLocat	00:00:00	12:02:47	NO (Size Center Time FPAlt Fence)	APM-103	Disarmed, Manual	Standby	1.0/1.0 (-2.9)	0 m/s	0.1 m/s	99% (12.59v)
☑	APM-104	SetDanceLocat	00:00:00	12:02:47	NO (Size Center Time FPAlt Fence)	APM-104	Disarmed, Manual	Standby	1.0/1.0 (-3.0)	0 m/s	0 m/s	99% (12.59v)
☑	APM-105	SetDanceLocat	00:00:00	12:02:47	NO (Size Center Time FPAlt Fence)	APM-105	Disarmed, Manual	Standby	1.0/1.0 (-3.1)	0 m/s	0.1 m/s	99% (12.59v)
☑	APM-106	SetDanceLocat	00:00:00	12:02:47	NO (Size Center Time FPAlt Fence)	APM-106	Disarmed, Manual	Standby	1.0/1.0 (-2.7)	0 m/s	0.1 m/s	99% (12.59v)
☑	APM-107	SetDanceLocat	00:00:00	12:02:47	NO (Size Center Time FPAlt Fence)	APM-107	Disarmed, Manual	Standby	1.0/1.0 (-2.8)	0 m/s	0.1 m/s	99% (12.59v)
☑	APM-108	SetDanceLocat	00:00:00	12:02:47	NO (Size Center Time FPAlt Fence)	APM-108	Disarmed, Manual	Standby	1.0/1.0 (-2.9)	0 m/s	0.1 m/s	99% (12.59v)
☑	APM-109	SetDanceLocat	00:00:00	12:02:47	NO (Size Center Time FPAlt Fence)	APM-109	Disarmed, Manual	Standby	1.0/1.0 (-3.0)	0 m/s	0.1 m/s	99% (12.59v)
☑	APM-110	SetDanceLocat	00:00:00	12:02:47	NO (Size Center Time FPAlt Fence)	APM-110	Disarmed, Manual	Standby	1.0/1.0 (-3.2)	0 m/s	0.1 m/s	99% (12.59v)

Figure 13. Displaying connected vehicles in UgCS with flight lines to firs point of the dance

First, check status columns in UgCS DDC. The following columns are important before setting time:

- ONBOARD TIME – displays flight controller time, which should be the same for all vehicles with 2-second error max.

- DANCE READY – before setting time, the status should be exactly NO (Time) and nothing else.
- ALT GPS(AGL) – should be the same for all vehicles with 1-meter error.
- PATH LENGTH – depending on a dance path plan, should be equal or similar for all vehicles.
- MAX RELATIVE ALT – maximum altitude relative to a take-off position during a dance.
- MAX DIST FROM CENTER – maximum distance from a Dance center during a dance.
- MAX HOR/VER SPEED – maximum speed a vehicle should reach during a dance.
- FPS – should be equal for all vehicles.

GPS FIX	VIBRATIONS	DATALINK	PATH LENGTH	OFFSET TO START	MAX RELATIVE ALT	MAX DIST FROM CENTER	MAX HOR SPEED	MAX VER SPEED	FPS
RTK fix (10)	0.01,0.01,0.01	99 %	867	H:1.2 m, V:9.0 m	52.9 m	16.9 m	2.1 m/s	2.1 m/s	4
RTK fix (10)	0.01,0.01,0.01	99 %	867	H:0.8 m, V:9.0 m	52.1 m	16.9 m	2 m/s	2 m/s	4
RTK fix (10)	0.01,0.01,0.01	99 %	867	H:1.3 m, V:9.0 m	49.7 m	16.9 m	2 m/s	1.7 m/s	4
RTK fix (10)	0.01,0.01,0.01	99 %	867	H:2.0 m, V:9.0 m	44.8 m	16.9 m	2.8 m/s	1.5 m/s	4
RTK fix (10)	0.01,0.01,0.01	99 %	867	H:2.9 m, V:9.0 m	48.6 m	18.4 m	3.4 m/s	1.7 m/s	4
RTK fix (10)	0.01,0.01,0.01	99 %	867	H:0.8 m, V:9.0 m	42.6 m	18.4 m	3.4 m/s	1 m/s	4
RTK fix (10)	0.01,0.01,0.01	99 %	867	H:0.2 m, V:9.0 m	42.8 m	16.9 m	2.8 m/s	0.8 m/s	4
RTK fix (10)	0.01,0.01,0.01	99 %	867	H:1.0 m, V:9.0 m	46 m	16.9 m	2.1 m/s	1.2 m/s	4
RTK fix (10)	0.01,0.01,0.01	99 %	867	H:1.9 m, V:9.0 m	55.7 m	16.9 m	2.1 m/s	2.1 m/s	4
RTK fix (10)	0.01,0.01,0.01	99 %	867	H:2.8 m, V:9.0 m	52.1 m	16.9 m	2 m/s	2 m/s	4

Figure 14. Status columns

If all status parameters are safe and all vehicles have Dance ready (time) status (meaning that everything is ready for a dance), specify the dance start time. The offset to start is defined under Options/General options/Dance start interval.

Figure 15.

Now the commands must be executed in the following order:

1. ARM.
2. SET TIME.
3. UPLOAD TIME.
4. DANCE.

After the dance, execute the LAND command.

Troubleshooting

This section describes various non-standard situations, which might occur during mission performance.

The vehicle cannot be armed.

- Make sure that communication link is good, check if GPS/Compass and other sensor status is sufficient. If that does not help, try power-cycling the vehicle. If everything fails, contact support@ugcs.com.

The vehicle cannot be armed and "The path cannot be found. Please try to change the location of the basic point(s) or values or parameters" is displayed in UgCS DDC.

- Make sure that the vehicle current location is within fence radius. The radius is calculated from Home Location.

Route cannot be uploaded to a vehicle.

- It is likely that a communication link is poor and UgCS is having trouble sending route data to a vehicle. Try placing the vehicle closer to the ground end of communications module.

During a flight, a vehicle suddenly returns home.

- Check fence radius and altitude, since it is likely that a vehicle has hit fence limits.

When starting UgCS DDC Client, the following message appears:

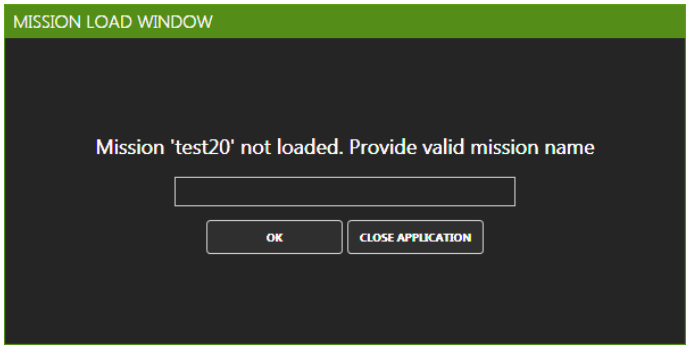

Figure 25. Mission Load Window

This message appears when the mission that is configured to work with UgCS DDC is either removed or renamed. Either enter the new mission name in the input field or change the mission

name to the previous one in UgCS Client. Note: UgCS DDC needs to be restarted if the mission name was changed.