LEICA BLK ARC-UI

How to use v2.0.0







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LEICA BLK ARC-UI

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LEICA BLK ARC-UI autonomous laser scanning module

INTRODUCTION

BLK ARC, where ARC stands for Autonomous Reality Capture, is the first autonomous laser scanning module fully designed for integrations with robotic platforms. The autonomous journey of the BLK ARC begins with capturing 3D data in any area where a robotic carrier can go, and at the same time using this accurate laser scanning data for robot's navigation.

The first robotic integration of BLK ARC is with the Boston Dynamics SPOT robot. Users can simply plan automated scan path and BLK ARC will command the robot to scan whenever and wherever needed. BLK ARC can be easily integrated across many industries and that is why this device was designed for use on many different robotic platforms and carriers.

GENERAL WORKFLOW FOR BLK ARC ON SPOT

- 1. Required 3rd party components:
 - a. Spot robot from Boston Dynamics
 - b. Spot Core from Boston Dynamics
 - a. There are 3 methods described how to manage networking with Spot and enable online connection for upload to HxDR. It can be done using 3rd party WiFi dongle plugged into Spot CORE or existing WiFi network in reach of robot and tablet with BLK ARC-UI or ethernet connection with docking station. Please refer to Networking with Spot chapter for more details.



- 2. Mount BLK ARC module on the Spot using dedicated accessories GAD126, GAD127 and GAD128
- 3. Mount GA03 on the Spot using dedicated accessory GAD130 (only for outdoor missions, see details in *overview on possible workflows*)
- 4. Install BLK ARC-UI on Spot Core using Portainer
- 5. Create an offline mission file in Cyclone 3DR software
- 6. Upload the mission file to BLK ARC-UI and complete the mission in the field

All required documentation can be downloaded from: <u>https://myworld.leica-geosystems.com</u>



LEICA BLK ARC-U

GENERAL INFORMATION

The installer can be downloaded from <u>https://myworld.leica-geosystems.com</u> Before starting the installation, make sure you have BLK ARC mounted on the robotic carrier properly.

For detailed instructions on how to mount BLK ARC on Spot robot check the Leica BLK ARC and GAD126/GAD128 Installation Guides. For detailed instructions on how to mount GA03 on Spot robot check the Leica GA03 and GAD130 Installation Guide. All documents are attached to accessories or available to download from https://myworld.leica-geosystems.com. It is always recommended to use the latest firmware of BLK ARC in a combination with the latest version of BLK ARC-UI.

SPOT VERSION CHECK

Required 3rd party components are Boston Dynamics Spot robot and Spot CORE. BLK ARC-UI is compatible with Spot v3.2.x. Make sure that your Spot, Spot CORE and Boston Dynamics Spot App are upgraded to version 3.2.x and Portainer version 2.1.1 or newer, before starting the installation of BLK ARC-UI.

Check in the Spot App

On the Boston Dynamics controller (Spot App) open the **About** section and check if robot and tablet are running the same software versions compatible with BLK ARC-UI. Make sure that the Spot CORE has also a compatible version installed.

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BLK ARC

Example:

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PORTAINER ACCESS AND USER ACCOUNT

- 1. Extract the folder with installer. You should now have the following two files:
 - blkarc-ui_v2.0.0_xxx.tar
 - blkarc-ui_v2.0.0_xxx.yml
- 2. Connect your computer to the carrier. The easiest way is to connect directly to the robot's Wi-Fi access-point.

More information about the network-setup can be found in the documentation of Spot provided by Boston Dynamics.

- 3. Open your preferred browser and type this address:
 - https://192.168.80.3:21900
- 4. A security risk warning might appear. If you get this warning, click **Advanced**... and **Accept the Risk** and **Continue**
- 5. If you use Portainer for the first time, you will be asked to create an account. If so, create your account.

Additionally, after logging in, a screen will show up asking to connect to an environment. Select **Local** and confirm by selecting **Connect**

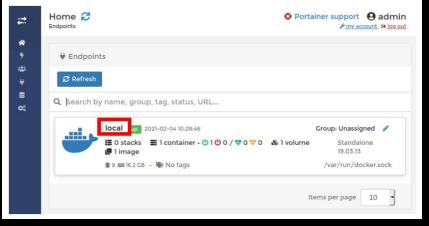
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Connect Portainer to a remote Docker environment using the Docker API over TCP. The Docker API must be exposed over TCP. You can find more information about how to expose the Docker API over TCP in the Docker documentation. Environment Name a.g. docker-prod01	information.			
	100 million 100	e.g. docker-prod01		
e.g. 10.0.0.10.2375 or mydocker.mydomain.com.2375	Endpoint URL	e.g. 10.0.0.10:2375 or mydocker.myd	formain.com.2375	

6. If you have used Portainer before, login with the account you have previously defined.



DOCKER IMAGE IMPORT

1. After successfully logging in in the previous section, you should see the following screen. Click on **local** marked on the image



2. On the next screen navigate to Images on the left side of the screen. In the screen which appears now click on **Import**

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	Remove - Build a new image Limport & Export	

3. Under Select file select the file blkarc-ui_v2.0.0_xxx.tar, which you downloaded previously and click on Upload

IMPORTANT: Please note that the upload might take several minutes. Do not interrupt this process by clicking anywhere else. A successful upload will be indicated by a small pop-up and the progress wheel of the Upload button will go away.



STACK CONFIGURATION

- 1. On the left side of the screen navigate to **Stacks**. In the screen which appears now click on +Add stack
 - Enter the name **blkarc-ui** (the name must consist of lowe case alphanumeric characters, '-' or '_')
 - Then select Upload Upload from your computer
 - In the bottom press Select file and select the file blkarc-ui_v2.0.0_xxx.yml, which was downloaded previously
 - In the very bottom of the page, select **Deploy the stack**
- 2. All stacks of BLK ARC-UI should now appear in the Stack list on the Stacks page

3. Example: 6 - C A 2 x * 1 4 🗊 portainer.io 📰 edmin Container list 💋 ► Start ■ Step @ Kill Ø running 50 in >_ Images Networks Volumes Events Host SETTINCS Users Endpoints Registries running B 0 is >_____ running B 0 is >_____ blkarc-ul.1.1.0_a17d7a1 2022-05-12 15:03:04 💐 administrato THO BLKARC INT 1 blkarc-ui-110 a77d7a1 2022-05-12 15:03:02 St administrati running B O Im >_ 2022-05-12 15:03:02 running B 0 km >____ running

IMPORTANT: In case the Stack cannot be deployed and Portainer gives you an error, open Containers panel, select two containers below and **Stop** them:

- Fire_ext_detector
- Ncb_daq_plugin

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portainer.io 211	6									

It might also be required to delete the failed containers manually before trying again.



CONTAINERS CHECK

Once the stack is properly configured, on the left side of the screen navigate to **Containers** and check if the following containers are running, and at the same time the following containers are stopped as in the picture:

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			1000 Sec. 1						Remaine page 10 - +
portanecio 21	ü	8							

DE-INSTALLATION OF BLK ARC-UI

- 1. To de-install BLK ARC-UI connect your computer to the carrier and access Portainer in the same way as during installation
- 2. Navigate to local
- 3. On the left side of the screen go to Stacks. Select **BLK ARC-UI** and **Delete**
- 4. On the left side of the screen go to Images. Select blkarc-ui_v2.0.0_xxx.tar and Delete

DE-INSTALLATION OF BLK ARC-UI

1. In order to upgrade to new version of BLK ARC-UI please de-install the old one and follow the steps on how to install new version starting with an empty setup.

PAYLOAD AUTHORIZATION

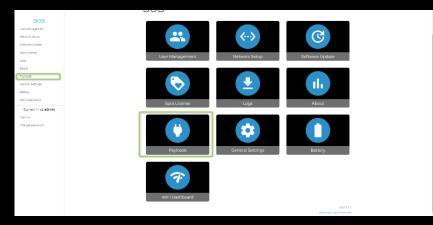
To properly register the payloads, after successful installation of BLK ARC-UI, it is recommended to follow the steps below:



1. Access Admin Console via https://192.168.80.3

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		Boston Dynamics					
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2. Go to Payloads

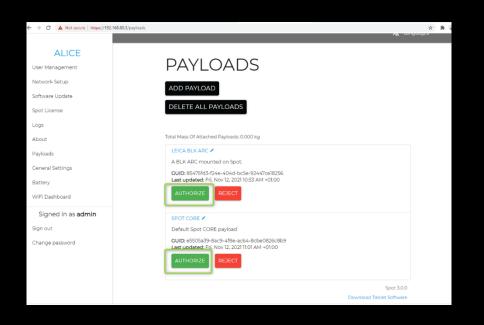


3. Forget/Reject all existing payloads (including older payloads for BLK ARC or UAX Connect or Spot CORE)

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User Management	PAYLOADS	
Network Setup	FAILOADS	
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Spot License	DELETE ALL PAYLOADS	
Logs	DELETE ALL PAYLOAUS	
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Payloatis		
General Settings	SHOT CORE / Detaut Spot CORE parload	
Belley	GUID 1005379b bar9 4845 9bar 07850879a	
W/FI Dashboard	Last updatest: Pn Nev 12, 2021 5 59 AM +01:00	
Signed in as admin	MUTHORIZE REJECT	
Signaut	SPOT CORE /	
	A Spot CCRE payload attached to the rear of the robot with no lider.	
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	Autoritation No. 1. Contraction	
	Sour 300 Examined Source Sources	

- 4. Restart Spot
- 5. After reboot, the latest payloads will appear. Access Admin console again, and Authorize new payloads for BLK ARC and Spot CORE







LEICA BLK ARC-UI

GENERAL INFORMATION

This chapter will guide you through the required steps to manage networking with your Spot robot.

There are different options to connect Spot CORE to the internet, the following table should give you a quick overview of the available options:

WiFi Dongle	Spot's WiFi	Spot's Ethernet
A USB-WiFi-Dongle is directly inserted into Spot CORE. This Dongle is used to connect to a pre-existing WiFi-Network, which provides the Internet-Access.	Spot's own WiFi is configured in Client- Mode, which means that it connects to a pre-existing WiFi-Network on the outside.	Spot and the docking-station each have an Ethernet-Port, which can be used to connect Spot to a preexisting network by cable.
Controlling Spot doesn't depend on an external network.	No additional 3rd party hardware is necessary.	Fastest possible upload-speeds. Spot still hosts its own WiFi, which
Spot still hosts its own WiFi, which can be used to access BLK ARC-UI	It is possible to control Spot using BLK ARC-UI from wherever you have access to this WiFi Network.	can be used to access BLK ARC-UI through the well-known IP 192.168.80.3.
through the well-known IP 192.168.80.3. Network-Speed depends a lot on the	Knowledge of the WiFi-network required, in order to setup the connection correctly.	Upload is only possible while Spot is docked or while having an ethernet cable plugged in. This
WiFi-Dongle and drivers used.	Depends on a stable external WiFi.	means no upload during operation.
3rd party WiFi dongle is required.	A new IP has to be used to connect to BLK ARC-UI (and all other applications on Spot (Cockpit, Portainer,)	Knowledge of Ethernet-Network required in order to setup the connection correctly.

TOOLS

There are several tools used throughout this guide to set-up the network correctly. This section should give you a brief overview. Scroll up to this section whenever one of the tools is mentioned in the sections below.

1. Spot's Admin Console

This is a browser-based interface running on Spot (directly on Spot, not on Spot CORE). It provides access to all necessary settings on Spot, handles Spot's networking, lets you download logs and offers much more. In this guide we will use the **Network Setup** page.

More information on the Admin Console can be found in the <u>documentation provided by Boston</u> <u>Dynamics</u>.



Steps to reach the Network-Page of the Admin Console

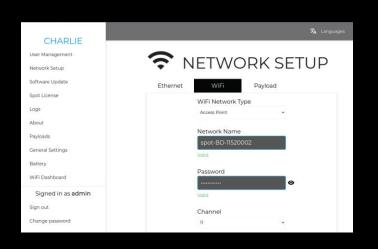
- 1. You can reach the Admin Console by connecting your computer to Spot and entering the corresponding IP-Address without any Port
 - a. If you are connected to Spot by using Spot's WiFi network (spot-BD-xxxxxxx), this IP should be <u>https://192.168.80.3</u>

	BostonDynamics
S	iign in to Charlie
	Username: admin Pessword:
	Spot 3.0.2 Download Tablet Software

- b. In this guide you will learn about connecting Spot with different networks. Based on these networks the IP used to access the Admin-Console will be different. Please use the IP introduced by the section dealing with your current connection type
- 2. The first time you try to access the **Admin Console** it might be that the browser asks you if you trust the page. Confirm the risk knowledge and proceed to the page
- 3. Login using the **admin** account of your Spot. The corresponding password was given to you with the delivery of the robot. The default one is written in the battery-compartment of Spot.
- 4. Click on Network Setup







2. Cockpit

This is a browser-based interface running on Spot CORE (not on Spot itself). It can be used to change settings on Spot CORE, offers networking-options, Logs, and has a terminal to directly access Spot CORE without SSH. In this guide we will use the **Networking** page.

More information on Cockpit can be found in the documentation provided by Boston Dynamics.

Steps to reach the Networking-Page on Cockpit

- 1. Make sure Spot is running and Spot CORE is connected and authenticated on the rear payload-port of Spot
- 2. Reach **Cockpit** by connecting your computer to Spot and entering the corresponding IP-Address on port **21443**
 - When connected to Spot by using Spot's WiFi network (spot-BD-xxxxxxx), this IP should be <u>https://192.168.80.3:21443</u>
 - b. In this guide you will learn about connecting Spot with different networks. Based on these networks the IP used to access the Admin Console will be different. Please use the IP introduced by the section dealing with your current connection type
- 3. The first time you try to access **Cockpit** it might be that the browser asks you if you trust the page. Confirm the risk knowledge and proceed to the page
- 4. Login using the credentials of your Spot CORE. Boston Dynamics provided these credentials when you got your Spot CORE delivered



Ubuntu 18.04.5 LTS Uer rame got Paseod Reader Reader Reader Description Descri	← → C	O & ↔ https://192.168.80.3:21443		
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Usually when you login for the first time or if you performed a Spot CORE's factory reset, default credentials are:

Username: spot

Password: password

5. Click on Networking

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en e	SpotCORE	SpotCORE running Ubuntu 18.04.5 LTS		Restart 💌			
2 Dashboard							
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	Storage	Bug Fix Updates Available	Memory 2.4 / 15.1 GiB				
	Networking						
			View graphs				
		System information	Configuration				
Services 🛕		Model To Be Filled By O.E.M. To Be Filled By O.E.M.	Hostname	SpotCORE edit			
	Applications	Asset tag U755475	System time	Dec 8, 2021 9:29 AM			
	Software Updates 🚯	Machine ID a00bced8b68a4eaf92ef039fd357db93	Domain	Join Domain			
			Performance profile	none			
			Secure Shell keys	Show fingerprints			
		View hardware details	Store metrics				



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	Logs Storage					
	Networking	Interfaces		Add Bond Add E	Bridge Add VLAN	
	Docker Containers					
	Virtual Machines	Name	IP Address	Sending	Receiving	
	Accounts	br-6d49c29d032d	172.23.0.1/16	No carrier		
	Services 🔺	br-72fea4ce3331	172.19.0.1/16	No carrier		
		br-8e82b65f619f	172.22.0.1/16	No carrier		
	Applications	br-afdfb4912bOb	172.24.0.1/16	No carrier		
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	Oproada	enp0s20f0ul	192.168.42.2/24	7.86 Kbps	6.50 Kbps	
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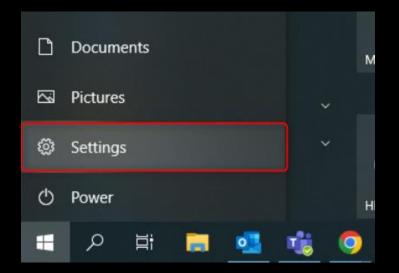
3. Find the Default Gateway / Route

To correctly route the internet traffic from Spot to the outside world, Spot needs to know about the **Default Gateway** (**Default Route**) of the network. This is the IP of the device on the network which is connected to the internet. For a WiFi-Network this would be the WiFi-Router's address. This section provides you with an overview on how to get the Default Gateway for WiFi- and Ethernet-Connections on Windows.

a. WiFi-Network on Windows

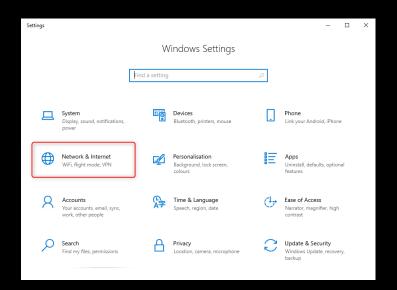
Instructions on how to find your WiFi-Network's Default Gateway on Windows

1. Open the **Settings** (Windows icon \rightarrow Settings)





2. Go to Network & Internet page

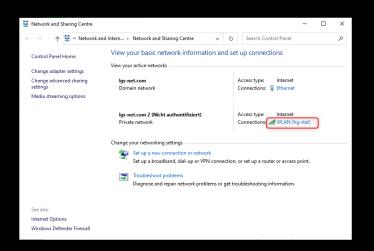


3. Go to the WiFi page and open the Network and Sharing Center

← Settings		- 🗆 ×
د Home	WiFi	
Find a setting	WLAN	Connect to a wireless network
Network & Internet	On Show available networks	If you don't see the wireless network you want, select Show available networks. select the one you want, and select Connect.
🔁 Status	Hardware properties	
di WiFi	Manage known networks	Related settings Change adapter options
臣 Ethernet	Random hardware addresses	Change advanced sharing options
n Dial-up	Use random hardware addresses to make it harder for people to track your location when you connect to different WiFi networks. This setting applies to new connections.	Network and Sharing Centre
98º VPN		Windows Firewall
후 Flight mode	Use random hardware addresses	Get help
0y0 Mobile hotspot		Give feedback
Prov	Hotspot 2.0 networks Hotspot 2.0 networks make more source connect to public Wifi topotots. The imprime be available in public places like airports, hoteks and cafes. Late we use Ones light-out get connected I and the source of the sou	



4. Select your WiFi-Connection



5. Click on Details...





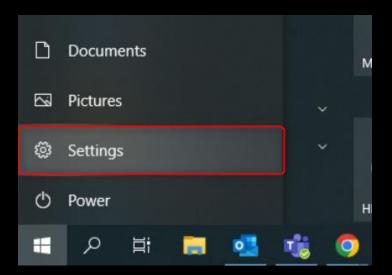
6. Find IPv4 Default Gateway

Network Connection Details				
Network Connection Details:				
Property	Value			
Connection-specific DN	lgs-net.com			
Description	Intel(R) Wi-Fi 6 AX201 160MHz			
Physical Address	9C-29-76-19-50-B4			
DHCP Enabled	Yes			
IPv4 Address	10.60.100.80			
IPv4 Subnet Mask	255.255.252.0			
Lease Obtained	11 May 2022 10:34:35			
Lease Expires	11 May 2022 11:34:35			
IPv4 Default Gateway	10.60.103.5			
IPv4 DHCP Server	192.0.2.1			
IPv4 DNS Servers	194.11.90.70			
	194.11.92.70			
IPv4 WINS Server				
NetBIOS over Tcpip En	No			
Link-local IPv6 Address	fe80::24ce:ec1f:43e7:bcdc%21			
IPv6 Default Gateway				
IPv6 DNS Server				
		_		
		-		
	Close			

b. Ethernet-Network on Windows

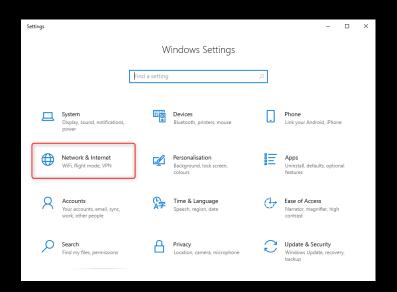
Instructions on how to find your Ethernet-Network's Default Gateway on Windows

1. Open the **Settings** (Windows \rightarrow Settings)





2. Go to Network & Internet page

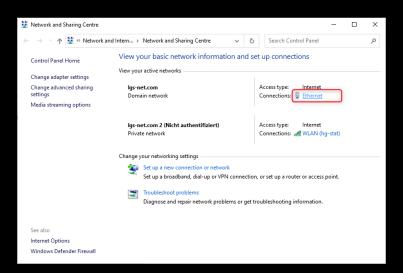


3. Go to the Ethernet page and open the Network and Sharing Center

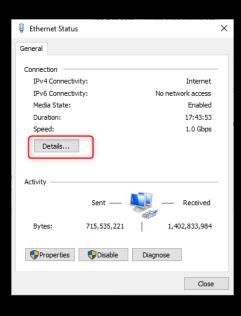
← Settings			ंत्र		×
G Home	Ethernet				
Find a setting		Related settings			
	Igs-net.com Connected	Change adapter opti	ons		
Network & Internet		Change advanced sh	aring op	tions	
🕏 Status		Network and Sharing	Centre		
🖉 WiFi		Windows Firewall			
🔛 Ethernet		Get help			
n Dial-up		Give feedback			
oge VPN					
화 Flight mode					
ባባ Mobile hotspot					
Proxy					



4. Select your Ethernet-Connection



5. Click on Details...





6. Find IPv4 Default Gateway

Network Connection Details				
Network Connection Details				
Property	Value			
Connection-specific DN	lgs-net.com			
Description	Realtek USB GbE Family Controller			
Physical Address	64-C9-01-EF-97-1D			
DHCP Enabled	Yes			
IPv4 Address	10.60.44.242			
IPv4 Subnet Mask	255.255.254.0			
Lease Obtained	10 May 2022 16:58:34			
Lease Expires	18 May 2022 16:58:35			
IPv4 Default Gateway	10.60.44.5			
IPv4 DHCP Server	194.11.90.80			
IPv4 DNS Servers	194.11.90.70			
	194.11.92.70			
IPv4 WINS Server				
NetBIOS over Tcpip En	No			
Link-local IPv6 Address	fe80::6d50:30fe:8ce8:21f1%10			
IPv6 Default Gateway				
IPv6 DNS Server				
		_		
	Close			

OPTION 1: SETUP INTERNET CONNECTIVITY BY USING A WIFI USB-DONGLE

To enable Internet connection on Spot CORE using this method, it is necessary to use **an external WiFi USB-Dongle** that must be connected to the Spot CORE.

Examples of recommended WiFi USB-Dongles

- TP-Link TL-WN823N
- TP-Link TL-WN725N

Although a suitable WiFi dongle has been used, the maximum WiFi speed may still not be achievable with the pre-installed driver on the Spot CORE.

Important: To setup the network, it is required to do a one-time configuration through the Boston Dynamics Cockpit and enable the network connection on Spot CORE. Please refer to this <u>link</u> for detailed instructions.

Instructions on how to setup Internet Connectivity by using a USB-Dongle

- 1. Plug the USB-Dongle into one of the USB-Ports of Spot CORE. Make sure the dongle is connected to the Spot CORE before starting the Spot robot
- 2. Start Spot
- 3. Make sure there is no Gateway defined in Cockpit:
 - a. Go to cockpit's Network page



b. On the networking page click on the Interface enp2s0

 Networking 	- Speccold 🗙 🔺					× -	٥
$\varepsilon \to \sigma$	A Not secure Https://192.168.80.3.21443	S/natacrk				2 9 8	а а
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	Sporcore				Sminutes •	۹.	5
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		0 M04 M05 M06	14.00 0 140	04 W-05 W-04	11.27	14.00	1
	Storage						
	Networking Docker Containers	Interfaces			Add Birdge	Add VLA	
	Virtual Machines	Kane	IP Address	Sending	Beceiving		
	Accounts	8-465835746234	17218-01/16	TE Klaps	150 Kbps		
	Services 🔺	8r-d03408ab/87	17239/03/16	No carrier			
		dicke0	172370346	Oltops	Obps		
	Applications	enal		Not evaluable			
	Software Updates	erp0s208ul	192.108.42.2/24	2018bps	10.7 Kbps		
	Terminal	enpile0	P92.168.50.5/24	283 Kbps	12140ps		
	Uploads	witer0	192.168123.1/24	No carrier			
		wig3e0	K0-60100-89/22	Ohps	0.00Fbps		
		wix7cc2c858w26	10/60/00/69/22	651 Kbps	257 Kbps		
		Unmanaged Interfaces					
		Name	IP Address	Sending	Receiving		
		web0076433					
		vethISS/IIS					

c. Click on the text next to IPv4

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$\varepsilon \to \sigma$	A Not secure Wige//192.168.80.	121443/sutwork#/imp2x8		2 A B D B 1
UBUNTU				🕲 Hulp 🕘 spot •
	Speicore	Resoluting 3 exp2x0		
EB Derhboard	Q Search		5 minutes	• • •
	Overview	Mgn Sending Mgn Receiving		
	Logs Storage	600		
	Networking	0 M05 M05 M05 M05 M05	14.07	HOB
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d. Make sure there is no entry in the field **Gateway** and no entry in **DNS**. Delete if something is in there. The window should look like the picture below

 Networking 	- SportCORE # +			∨ – Ø ×
$\varepsilon \to \sigma$	A Not secure https://192.5	80321441/intervali#(ing2st)		12 9 8 1 4 1
UBUNTU			A Privleged	🕲 Help 🍵 spot •
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		step Sending		
		120 192360.50.5 24 Gateway -		
		3400		
	Networking	DNS Automatic 💭 🕂		Mich and Andrea
	Docker Containers			
		eng2x0 Realtek Semiconductor Co., Ltd. HTLBIT: DNS Search Domains Automatic 🕥 主 29.43		
	Accounts	Status 992365505/24, fe80.0.0.0.67a57793		
	Services	Carrier 1Glips Routes Automatic 💽 🔸		
		General Consect autometically PM Actives N218250.5/24 92368.80.0 24 92368.80.3 0		
	Applications			
	Software Updates	1944 Automatic 10000 8 192368503 0 -		
		Casel Apply		_
	Uploads	Caller 444		

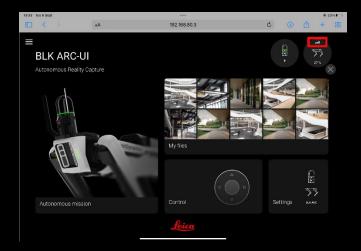
- e. Click on Apply to save these settings
- 4. Go to BLK ARC-UI, select Settings and **press add on WiFi.** A pop-up window will open and it will be possible to select the **SSID** and write **Password** of your WiFi-Network



13:41 Tue 6 Sept		***	@ 20%]
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≡ ← Beck to dashboard Settings			···· ···· ···· ····
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Scanner	BLK ARC on U			
		Create a new profile		
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5. Once connection is established the icon should appear above Spot icon in the top right corner.



6. Enjoy upload of your files to HxDR!

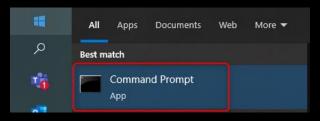


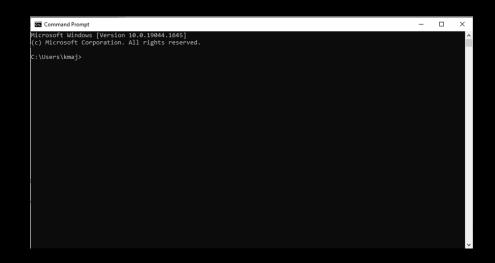
OPTION 2: SETUP INTERNET CONNECTIVITY BY USING SPOT'S WIFI

WARNING: Changing the WiFi-Connection to Client-Mode will stop Spot's own WiFi-Network. You will only be able to access Spot on the new IP-address you assign in this section from within the same network. It might be wise to first look for a backup-connection to connect to spot, like plugging in an Ethernet cable between your laptop and Spot.

Instructions on how to setup Internet Connectivity by using Spot's WiFi

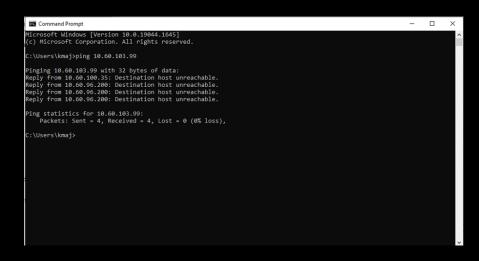
- 1. Find a unique IP-address to use on your WiFi-Network:
 - a. Search your WiFi-Network's **Default Gateway**. Remember it, as you will need it again further below
 - b. Select an IP-Address for Spot:
 - i. This address needs to be on the same domain as your **Default Gateway**. This means that the first three blocks of numbers in the IP need to be the same
 - ii. The fourth block needs to be unique in your network. It is recommended to choose a rather high number between 75 and 250. Let's take **99** as an example
 - iii. For a sample **Default Gateway** of **10.62.254.2** your selected IP would now be **10.62.254.99**
 - iv. Check that there is no device on this IP:
 - 1. Connect your computer to the WiFi-Network you later want to connect Spot to
 - 2. Open a terminal (search for CMD under windows)







 Ping the IP-Address you selected and make sure there is no reply (for example: ping 10.62.254.99)
 If no device is on this IP, you should get an output like Destination host unreachable

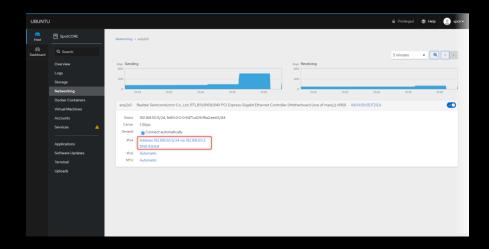


- 4. **Important**: Ideally you contact your network administrator and ask him to assign a fixed IP-Address for Spot directly on your router! This would be the proper way!
- 2. Remove the WiFi-Dongle if it was still plugged into Spot CORE
- 3. Connect your computer to Spot's WiFi (spot-BD-xxxxxxx) or the network currently used to connect to Spot
- 4. Setup the Gateway on Spot CORE in order to route internet-traffic from Spot CORE to Spot:
 - a. Go to Cockpit's Network page
 - b. On the networking page click on the Interface enp2s0

UBUNTU											ivileged	Help	spot -
en Host	SpotCORE									5 minut	tes 🔹	Q	-
20 Dashboard	Q, Search	Raps Sending					Khps Receiving						
	Overview	400					400						
	Logs	0 10:22	10.23	10:24	10.25	10:26	0	10:22	10:23	10.24	10.25	10.	:26
	Storage												
	Networking	Interfaces								Add Bond	Add Bridge	Add VLAN	
	Docker Containers Virtual Machines	Name			IP Address							AND VEAN	7
	Accounts	br-4aaa404b29d2			IP Address 17218.0.1/16			Sending 66.9 Kbps		Receivin			
	Services A	docker0			17210.0/16			0 bps		0 bps			
		enol						Not available		0.001			
	Applications	enp0s2010u1			192.168.42.2/24			219 Kbps		20.8 Kbp	16		
	Software Updates	enp2s0			192.168.50.5/24			132 Kbps		57.6 Kbp	5		
	Terminal	vitrO			192.168.123.1/24			No carrier					
	Uploads												
		Unmanaged Interfaces											
		Name			IP Address			Sending		Receivir	8		
		veth34b577b veth5130200											
		veth5fbac2f											
		veth69afa88											
		veth9ab1348											
													_



c. Click on the text next to IPv4 (text might look different)



d. Write **192.168.50.3** into the **Gateway**. Click the **+** symbol under **DNS** to add a new entry. Write **8.8.8.8** into the text-field

UBUNTU					🕑 Help	🤵 spot 🕶
en Host	SpotCORE	Networking > exp2x0				
Deshboard	Q. Search	IPv4 Settings Addresses Manual -	×	5 minutes	• @	
	Overview	More Sending	•			
	Logs	192168.50.5 24 192168.50.3	-			
	Storage	a Automatic				
			10.29			10.31
		enp2s0 Realtek Semiconductor Co., Ltd. RTL 811	- \$2£A			
		Status 192,166,50,5/24, fe80,0.0.0,9471 at Opt DNS Search Domains Automatic 🔘 🗖				
		Status 192.168.50.5/24, fe80.0:0:0:9471a1099 DNS Search Domains Automatic O				
	High B SpotCORE Buildboard Q. Search Overview Logs	General Connect automatically Routes Automatic 💽				
	Applications	IPv4 Address 192.168.50.5/24 via 192.168.50.				
	Software Updates	19216630.0 24 19216350.3 0	-			
	Terminal	MTU Automatic 10.0.0.0 8 192/68.50.3 0	-			
	Uploads	Cancel	alu .			

- e. Click on Apply to save these settings
- 5. Change the WiFi-Network on Spot's Admin Console:
 - a. Go to the Network Setup page on Spot's Admin Console.
 - b. Go to the WiFi tab
 - c. Change the WiFi Network Type from Access Point to Client
 - d. Enter the name of your WiFi-Network under Network Name



e. Enter the Password under Password

👷 spot-80-13250016 Network Cori 🛪 🕂			σ	
€ → C A Notsecure Helper//192.1	82.82.3/vetwork-config#001	순 ☆	а а	1
ENRIQUE	7	Languages		l
User Management				
Network Setup	RETWORK SETUP			
Software Update	Ethernet WiFi Payload			
Spot License	WIFI Network Type			
Logs	Client *			
About				
Payloads	Network Name hg-stat			
Ceneral Settings	Viel -			
Battery				
WIFI Dashboard	WIFI Security Type			
Visualizer	WDB2 Dersonal Security			
	Password			
Signed in as admin	•			
Sign out	Valid			
Change password	Password is Empty Check this to to consecuted networks that have no pensered.			
	Frequency Band			
	Al v			

- f. Enter the IP-Address you chose in the beginning of this section under IPv4 Address
- g. Enter **24** under **Route Prefix**. Depending on your network this could also be a different number. Please ask your network administrator
- h. Enter the Default Gateway under Stored Default Route
- i. Slide the lever to specify this connection as your Default Route under Is Current Default Route

Same AD-10010074 National Con K		~		0	х
← → C ▲ Not secure https://192.168.80.3/insteach-config#WFi		12	ŵ	4	÷
ENRIQUE User Management Network Setup Software Update	All				
Spot License Logs About Payloads	Route Prefix 24 Vilio				ļ
Caneral Settings Battery WiFi Doshboard Visualizer	Stored Default Route (1050/003) This is an explosit one associated with this configuration Church the To Garwer Default Route' because the at the active default mate.				
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j. Apply the settings by pressing on Apply

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€ → Ø ▲ Not secure Https://192.168.80.3/vetw	uk config##Fi	12 A 0 & 1
	W/d	
	Stored Default Poute	
User Management	APPLY NETWORK CHANGES?	
Network Setup	APPLY NETWORK CHANGES?	
Software Update	CANCEL APPLY	
Spot License		
Logs		
About		
Payloads		
Ceneral Settings		
Battery		
WiFi Dashboard		
Visualizer		
Classed in an admin	Channel	
Signed in as admin	1	
Change password		
	* Advanced	



If you have some issues with applying these settings, you should try to log out and log in.

- 6. Check that everything works:
 - a. Wait for ~1 minute in order to give Spot time to connect to the network. The previous page will no more be reachable and you should have lost the WiFi-Connection to Spot, as Spot has changed to Client-Mode

🛂 spor-80-13050016 Network Car 🗴 🕂	✓ -= 0 - ×
← → C ▲ Not secure Hitper/192	
	X Languages
ENRIQUE	
User Management	중 NETWORK SETUP
Network Setup	INLIWORK SLIDE
Software Update	Ethernet WiFt Payload
Spot License	
Logs	This robot can no longer be reached. This happens if you were connected to the robot over wifi and then changed the
About	will individe satchings. Please join the same will national as the robot and navigate to the IP address.
Payloads	 The constitution of the constiting of the constitution of the constitution of the constitutio
General Settings	WiFI Network Type
Battery WiFi Dashboard	Cient v
Visualizer	Network Name
	hg-stat
Signed in as admin	valid
Sign out	WiFI Security Type
Change password	WFA2 Personal Security 🐱
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ENRIQUE	
Utor Ma	Lost Connection to Robot
	the robot has been lost. This may be a temporary interruption, your session may have expired, or you may need to reconfigure your computer's or the robot's network settings and reconnect. Checking for connection again in 4 seconds.
Softwar	Lineolog for connection again in 4 seconds.
Spot Lic	
About	were connected to the lobot over while different field the
	with instances and hope both the same with instances and the installand and invested to their a balances
Battery	WiFi Network Type
	Cient +
	Network Name
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Signed in as admin	void
Sign out	WiFi Security Type
Change password	WPA2 Personal Security +
	Password
	•
	valid

- b. Connect your computer to the same network you specified for Spot
- c. You should now be able to reach the Admin Console by entering the IPv4-Address you specified further above (for example <u>https://10.62.254.99</u>)
- d. You should be able to reach BLK ARC-UI by additionally entering the port 21002 (for example <u>http://10.62.254.99:21002</u> (http, not https))
- e. You reach Portainer under port 21900 (for example https://10.62.254.99:21900)
- f. You reach Cockpit under port 21443 (for example <u>https://10.62.254.99:21443</u>)
- g. And finally you should be able to upload to HxDR from BLK ARC-UI

Instructions on how to revert Internet Connectivity from using Spot's WiFi (change WiFi back to Access-Mode)

1. Make sure there is no Gateway defined in Cockpit:



- a. Go to Cockpit's **Network** page (as described above, using the IP defined above, for example <u>https://10.62.254.99:21443</u>)
- b. On the networking page click on the Interface enp2s0
- c. Click on the text next to IPv4
- d. Make sure there is no entry in the field **Gateway** and no entry in **DNS**. Delete if something is in there
- e. Click on Apply to save these settings
- 2. Change the networking in the Admin Console back to Access-Mode:
 - a. Go to the **Network Setup** page on Spot's Admin Console (as described above, for example <u>https://10.62.254.99</u>)
 - b. Go to the WiFi tab
 - c. Change the WiFi Network Type from Client to Access Point
 - d. Apply the settings by pressing on Apply
 - e. Wait a minute to allow Spot to reconfigure its WiFi and then connect to Spot as usual:
 - i. Connect to Spot's WiFi
 - ii. For example access https://192.168.80.3 to get to the Admin Console

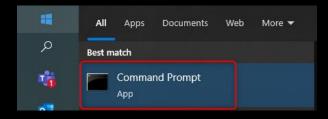
OPTION 3: SETUP INTERNET CONNECTIVITY BY SPOT'S ETHERNET

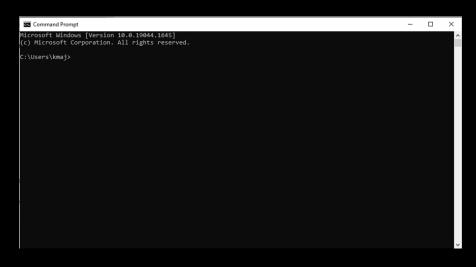
Instructions on how to setup Internet Connectivity by using Spot's Ethernet

- 1. Find a unique IP-address to use on your Ethernet-Network:
 - a. Search your Ethernet-Network's **Default Gateway**. Remember it, as you will need it again further below.
 - b. Select an IP-Address for Spot:
 - i. This address needs to be on the same domain as your Default Gateway
 - ii. This means that the first three blocks of numbers in the IP need to be the same.
 - iii. The fourth block needs to be unique in your network. It is recommended to choose a rather high number between 75 and 250. Let's take **233** as an example.
 - iv. For a sample **Default Gateway** of **10.62.80.70** your selected IP would now be **10.62.80.233**
 - v. Check that there is no device on this IP:
 - 1. Connect your computer to the Ethernet-Network you later want to connect Spot to



2. Open a terminal (search for CMD under windows)





3. Ping the IP-Address you selected and make sure there is no reply. (for example: **ping 10.62.80.233**)

If no device is on this IP, you should get an output like **Destination** host unreachable

Command Prompt	-	×
Microsoft Windows [Version 10.0.19044.1645] (c) Microsoft Corporation. All rights reserved.		^
C:\Users\kmaj>ping 10.60.45.233		
Pinging 10.60.45.233 with 32 bytes of data: Reply from 10.60.45.59: Destination host unreachable. Reply from 10.60.45.59: Destination host unreachable. Reply from 10.60.45.59: Destination host unreachable. Reply from 10.60.45.59: Destination host unreachable.		
Ping statistics for 10.60.45.233: Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),		
C:\Users\kmaj>		
		Ļ
		_

- 4. **Important**: Ideally you contact your network administrator and ask him to assign a fixed IP-Address for Spot directly on your network! This would be the proper way!
- 2. Remove the WiFi-Dongle if it was still plugged into Spot CORE



- 3. Connect your computer to Spot's WiFi (spot-BD-xxxxxxx) or the network currently used to connect to Spot
- 4. Setup the Gateway on Spot CORE in order to route internet-traffic from Spot CORE to Spot:
 - a. Go to Cockpit's Network page
 - b. On the networking page click on the Interface **enp2s0**

Networking					v -	
€⇒C	A Not secure https://192.168.80.3:21443	1/nebsork			2 × 1	
UBUNTU					🖴 Privileged 😗 Help 🤮	spot •
en Host	SpotCORE				5 minutes 🔹 🔍 <	>
(2) Dashboard		Mbjis Sending 1200 800	ktps Receivir 800			
	Overview	400	400			
	Logs	0 1239 1240 1241	12.42 12.43	12.39 12.40	12.41 12.42 12.43	2
	Storage					
	Networking					
	Docker Containers	Interfaces			Add Bond Add Bridge Add VLAN	
	Virtual Machines	Name	IP Address	Sending	Receiving	
	Accounts	br-4aaa404b29d2	172.18.0.1/16	97.7 Kbps	104 Kbps	
	Services 🔺	dockerO	172.17.0.1/16	0 bps	0 bps	
		enol		Not available		
	Applications	enp0s2010ul	192.168.42.2/24	212 Kbps	21.2 Kbps	
	Software Updates 0	enp2x0	192.168.50.5/24	106 Kbps	761Kbps	
	Terminal	vitir0	192.168.123.1/24	No carrier		
	Uploads	Unmanaged Interfaces				
		Name	IP Address	Sending	Receiving	
		veth4369eb3				
		veth4392aab				
		veth4c39987				
		veth67f8le3				
		veth9106b98				

c. Click on the text next to IPv4

Networkin	- SpecCAE x +		v	- σ	×
€ → C	A Not secure Hitps://192.168.80.3/21443/network#/enp2s0		1Ê 1	à 🖬	8.1
UBUNTU			🕑 Help	٠	pot •
Host	SportCoRE Networking > erp2x0				
20 Dashboard	Q. Search	5 minutes	- (9)		
	Australia Australia Australia Australia Australia Australia Batas Australia Yatas Australia Yatas Australia Yatas Yatas Yatas Yatas Yatas	5 moutes	12.40		

d. Write 192.168.50.3 into the Gateway



e. Click the + symbol under **DNS** to add a new entry. Write **8.8.8.8** into the text-field. The window should now look as in the picture

Networking	- SpotCORE × +								v - 0	×
	A Not secure Https://192.168.80.3/2	1443/network#/enp2s0							6 4 0 4	
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f. Click on Apply to save these settings

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	Uploads									

- 5. Change the Ethernet-Network on Spot's Admin Console:
 - a. Go to the Network Setup page on Spot's Admin Console



b. Go to the Ethernet tab



- c. Enter the IP-Address you chose in the beginning of this section under IPv4 Address
- d. Enter **24** under **Route Prefix**. Depending on your network this could also be a different number. Please ask your network administrator
- e. Enter the Default Gateway under Stored Default Route
- f. Slide the lever to specify this connection as your **Default Route** under **Is Current Default Route**
- g. Enter 8.8.8.8 under DNS Nameservers

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Battery		l	route.	et this as the active delaute		
WiFi Dashboard		ſ	Is Current Default Route			
Visualizer		l	There can only be one default route, so se in all other configurations.	etting this true here sets it false		
Signed in as admin			DNS Nameservers			
Sign out			8.8.8			
Change password			Valid			
			DNS Search Domains			
			Example: bostondy	namics.com		1
			MAC Address			
			10:36:4a:00:37:e6			



h. Apply the settings by pressing on Apply

Spot-BD-13050016 Network Corri 🗙 🕂		Ý	-	٥	×
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ENDIQUE	Route Prefix				
ENRIQUE	24				
User Management	APPLY NETWORK CHANGES?				
Network Setup					
Software Update	CANCEL				
Spot License					
Logs					
About					
Payloads					
General Settings					
Battery					
WiFi Dashboard					
Visualizer	DNS Search Domains				
Signed in as admin	Example: bostondynamics.com				
Sign out	MAC Address				
Change password	10:36:4a:00:37:e6				
	CLEAR CHANGES APPLY				

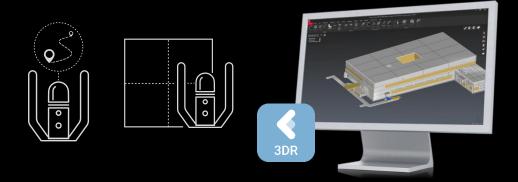
- 6. Check that everything works:
 - a. Wait for ~1 minute in order to give Spot time to connect to the network
 - b. Connect your computer to the same network you specified for Spot
 - c. You should now be able to reach the Admin Console by entering the IPv4-Address you specified further above (for example <u>https://10.62.80.233</u>)
 - d. You should be able to reach **BLK ARC-UI** by additionally entering the port **21002** (for example <u>http://10.62.80.233:21002</u> (http, not https))
 - e. You reach Portainer under port 21900 (for example https://10.62.80.233:21900)
 - f. You reach Cockpit under port 21443 (for example https://10.62.80.233:21443)
 - g. And finally you should be able to upload to HxDR from BLK ARC-UI



LEICA BLK ARC-U

It is recommended to use Cyclone 3DR for offline mission planning for BLK ARC. The dedicated scripts for BLK ARC are pre-installed in Cyclone 3DR v2021.2 and later or can be downloaded from https://myworld.leica-geosystems.com together with the BLK ARC-UI.

Use available scripts for defining the UCS (User Coordinate System) and draw the path in a fast and compatible way. The mission can be quickly exported and ready for further use with the BLK ARC. Below you will instructions on how to use both scripts.



GENERAL INFORMATION

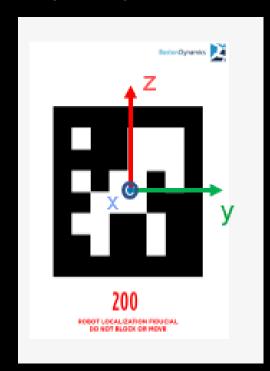
To create a mission, an input data of the existing environment is required. This data can be in a form of a point cloud, BIM model or floor plan.

For the planned mission to be executed, it is necessary to define one common point between the virtually planned mission and the real environment. For this purpose, Fiducial 200 (printable template attached) must be placed near the pre-defined starting point of the mission, where the robot will initialize.

The fiducial will be detected by Spot cameras. To achieve best results, follow best practices regarding how/where to mount a fiducial (for detailed instruction please refer to this <u>link</u>).



The first step to plan an offline mission is to locate the **Fiducial 200** in an available point cloud, BIM model or floor plan. Fiducial 200 contains information that will allow to automatically orient the UCS (User Coordinate System) according to the diagram below:



After that, a path which the robot will follow can be drawn. Then, it is possible to add pre-defined static scan positions. The final step is to export the path file in *.json format, which can later be imported into BLK ARC-UI.

In addition, starting with BLK ARC-UI version 1.2.0, you can export a supporting *.obj file for live **pose optimization** during missions. It improves localization during missions, reduces drift, especially in longer missions or where fiducial has not been detected accurately.

The BLK ARC-UI version 1.3.0 allows you to benefit from visual initialization of the mission for repetitive walks. It requires an additional 3D map file that can be generated automatically from a B2G file (coming from BLK ARC or BLK2GO) within HxDR platform. The detailed instruction on how to prepare the files, how to execute missions and what is the dedicated workflow can be found below.

The BLK ARC-UI version 2.0.0 allows you to **start and finish mission at the docking station**. In this case the any dedicated fiducial from Boston Dynamics can be used that is mounted on docking station. The number of the fiducial does not need to be specified in path planning.

OVERVIEW ON POSSIBLE WORKFLOWS



Options	Required files	Steps
Workflow 1 Autonomous mission	 Input file for path planning (accepted files:2D CAD, 3D BIM, 3D point cloud, 3D mesh) Mission file (*.json) 	In the office: -Import your input file for path planning into Cyclone 3DR -Perform mission planning and export mission file (*.json) Step 1: define UCS = Fiducial position; Step 2: draw the path <u>On site:</u> -Place real fiducial on site -Load mission file (*.json) into BLK ARC-UI -Place robot in front of fiducial and start mission <u>Important:</u> -Good light conditions on site when robot is detecting fiducial with cameras -Precise fiducial placement during path planning and on site
Workflow 2 Autonomous mission with pose optimization	 Input file for path planning (accepted files: 3D BIM, 3D point cloud, 3D mesh) Mission file (*.json) 3D model (*.obj) for pose optimization (3D mesh created out of point cloud or BIM model) 	In the office: -Import your input file for path planning into Cyclone 3DR. -Perform mission planning and export mission file (*.json) Step 1: define UCS = Fiducial position; Step 2: draw the path. -Export 3D model in *.obj file. <u>On site:</u> -Place real fiducial on site. -Load mission file (*.json) into BLK ARC-UI. -Load 3D model (*.obj) into BLK ARC-UI and attach to specific mission. -Place robot in front of fiducial and start mission. <u>Important:</u> -WCSs between mission file and 3D model for pose optimization need to be the same. 3D model must be exported in WCS from Cyclone 3DR. -3D model for pose optimization needs to be complete meaning covering the whole area of the mission.
Workflow 3 Autonomous mission with pose optimization and visual initialization for repetitive capturing	-Mission file (*.json) -Input file for path planning must be 3D mesh or point cloud based on *.b2g file -3D model (*.obj) for pose optimization based on *.b2g file -3D map (*.bytes) for visual initialization created in HxDR based on *.b2g file	<u>On site:</u> -Collect scan (*.b2g) on site that covers the area where repetitive mission will take place (data can be collected with handheld BLK2GO or BLK ARC). <u>In the office:</u> -Collected scan (*.b2g) file upload to HxDR. -Download created 3D map (*.bytes) and 3D model (*.obj) from this scan. -Import downloaded *.obj file for path planning into Cyclone 3DR (do not move or change WCS of *obj!). -Perform mission planning and export mission file (*.json), remembering that it is possible now to plan a mission that starts and ends at a docking station. Step 1: define UCS = Fiducial position; Step 2: draw the path <u>On site:</u> -Load mission file (*.json) into BLK ARC-UI -Load 3D model (*.obj) into BLK ARC-UI and attach to specific mission -Load 3D map (*.bytes) into BLK ARC-UI and attach to specific mission -Place robot close to starting position and start mission <u>Important:</u> -WCSs of mission file and 3D model for pose optimization need to be the same as scan (*.b2g) used for 3D map (*.bytes) -If visual initialization fails due to poor lighting condition or lack of features, use real Fiducial for traditional mission start as a fallback solution
Workflow 4	-GA03 & GAD130 (hardware)	On site:



Outdoor	-Internet	-Once GA03 is connected, start mission, and calibrate the GNSS module
missions with	connection on	outdoors
GA03	tablet/iPad with	-Tap points on the map to create a path and assign actions, which the robot will
	BLK ARC-UI to	follow and execute
	display map	
	background	

CREATE A PROJECT IN CYCLONE 3DR

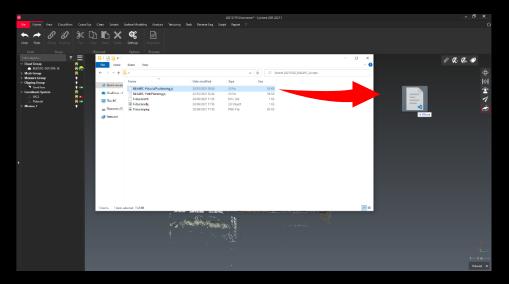
Create a new project in Cyclone 3DR and import the input data. Adjust the display options to your preferences (hide BIM model elements, add limit box, or limit plane).

If you are using Cyclone 3DR v2023.1 or later, go to the **Script** tab and select **BLK ARC Fiducial UCS** and later **BLK ARC Mission Planner** to run the scripts.

0													New Docu	ument	- Cyclone 3DR 2021.2	
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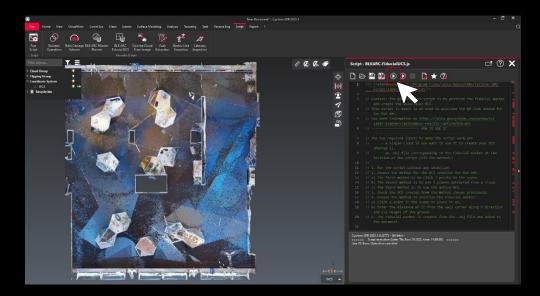
For older version of Cyclone 3DR, the scripts can be downloaded from https://myworld.leica-geosystems.com

To load the script simply drag & drop **BLK ARC Fiducial UCS.js** file.



Press **Play** to start. Follow the instructions described below or in the wizard displayed in Cyclone 3DR user interface. Once the Fiducial is defined properly, repeat the steps for **BLK ARC Mission Planner.js**.





BLK ARC FIDUCIAL UCS - METHOD 1: THREE POINTS (CAD / BIM)

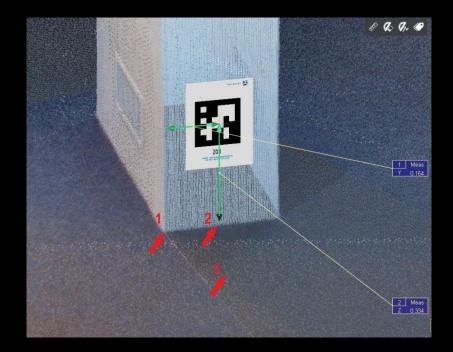
In the next steps the instruction for Method 1 will be explained.

1. Define the input data.

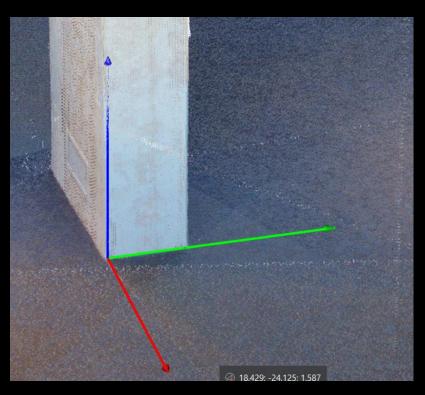
UCS	Creation for BLK ARC	_		\times
	List of methods			
	Method 1: Three points (CAD/BIM drawing)			
	Method 2: Three planes (Point Cloud) - not available, 0 or more than 1	cloud vi	sible	
	Method 3: Active UCS - not available, no UCS activated			
	Method 4: Docking station			
	Define your method (from 1 to 4)			
	OK Cancel			

- 2. Following the instructions below, pick 3 points:
 - a. One point in the corner taken as a reference (1),
 - b. One point on the edge between the wall and the floor (2), One in front of the wall where Fiducial is located (3).





- 3. UCS will appear. Check if the directions are correct:
 - a. X axis should be oriented external to the wall.
 - b. Y axis should be horizontal, aligned to the wall and pointing right.
 - c. Z axis should be oriented vertically (upward).



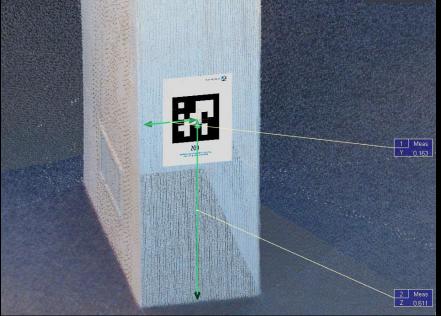
If any of the conditions above is not respected, restart the script, and repeat steps 1-3 (press ESC to close the script).



- 4. Move the Fiducial to the correct position. There are two options available:
 - a. Click a point on the model (y).
 - b. Manually enter the offset in relation to the Y and X axes (n):
 - Y axis \rightarrow Length on the selected surface
 - Z axis \rightarrow Height from the floor

	iducial position	_	\times	
	Do you want to click a point If you just want to click a poin Enter 'n' otherv Click a point (y) or enter a value (n): OK	nt, enter 'y' below.		
🚳 Fiducial posi	tion		_	×
Distanc	e of the fiducial to wall corner along Y direction	(can be negative!)		
Height	of the fiducial to ground 0	.3		
	ОК	Cancel		

- 5. As an output available are:
 - a. Properly oriented UCS
 - b. Properly placed Fiducial mesh
 - c. Distances calculated / entered from the edges





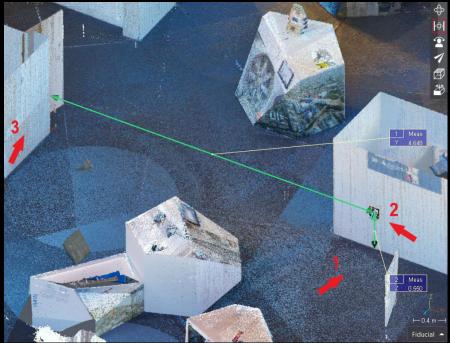
BLK ARC FIDUCIAL UCS – METHOD 2: THREE PLANES (POINT CLOUD)

In the next steps the instruction for Method 2 will be explained.

1. Define the input data

UCS	Creation for BLK ARC	_		×
	List of methods			
	Method 1: Three points (CAD/BIM drawing)			
	Method 2: Three planes (Point Cloud) - not available, 0 or more tha	n 1 cloud v	visible	
	Method 3: Active UCS - not available, no UCS activated			
	Method 4: Docking station			
	Define your method (from 1 to 4) 2			
	OK Cancel			

- 2. Following the instructions below, pick 3 points:
 - a. One point on the floor in front of the Fiducial (1)
 - b. One point on the wall where the Fiducial is located (2)
 - c. One point on a corner wall (3)



- 3. UCS will appear. Check if the directions are correct:
 - a. X axis should be oriented external to the wall
 - b. Y axis should be horizontal, aligned to the wall and pointing right



c. Z axis should be oriented vertically (upwards)



If any of the conditions above is not respected, restart the script, and repeat the steps 1-3 (press ESC to close the script).

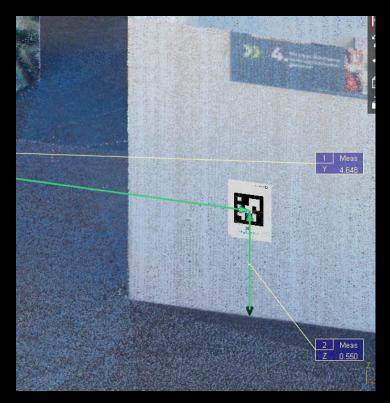
- 4. Move the Fiducial to the correct position. There are two options available:
 - a. Click a point on the model (y).
 - b. Manually enter the offset in relation to the Y and X axes (n):
 - Y axis \rightarrow Length of the selected surface
 - Z axis \rightarrow Height from the floor

Do you want to click a point or enter a value? If you just want to click a point, enter 'y' below. Enter 'n' otherwise! Click a point (y) or enter a value (n)? OK Cancel		iducial position	_	×
		If you just want to click a point, enter		
OK Cancel	1	Click a point (y) or enter a value (n): n		
		OK Cancel		



6 Fiducial position		-	×
Distance of the fiducial to wall corner along Y direct	ion (can be negative!)		
Height of the fiducial to ground	0.3		
ок	Cancel		

- 5. As an output available are:
 - a. Properly oriented UCS
 - b. Properly placed a Fiducial mesh
 - c. Distances calculated / entered from the edges



BLK ARC FIDUCIAL UCS – METHOD 3: ACTIVE UCS

In case the user prefers to manually set the UCS using the existing tools in the Cyclone 3DR, method 3 allows the automatic adaptation of the previously created UCS.

In the next steps the instruction for Method 3 will be explained.

- 1. Manually set a UCS that meets the following requirements:
 - a. X axis should be oriented external to the wall
 - b. Y axis should be horizontal, aligned to the wall and pointing right



- c. Z axis should be oriented vertically (upward)
- 2. Run the script and define the input data.

OUCS Creation for 	BLK ARC	—	\times
	List of methods		
	Method 1: Three points (CAD/BIM drawing) Method 2: Three planes (Point Cloud) - available, 1 cloud visib Method 3: Active UCS - available, UCS activated	le	
	Method 4: Docking station Define your method (from 1 to 4) 3 OK Cancel		

- 3. As an output available are:
 - a. Properly placed Fiducial mesh



BLK ARC FIDUCIAL UCS – METHOD 4: DOCKING STATION

Method 4 is designed to use for missions with a Docking Station available.

In the next steps the instruction for Method 4 will be explained.

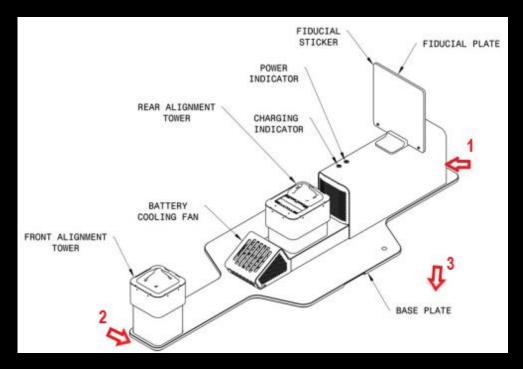
1. Define the input data



UCS Creation for B	3LK ARC	—	×
	List of methods		
ſ	Method 1: Three points (CAD/BIM drawing) Method 2: Three planes (Point Cloud) - available, 1 cloud visib Method 3: Active UCS - available, UCS activated Method 4: Docking station	le	
	Define your method (from 1 to 4) 4		

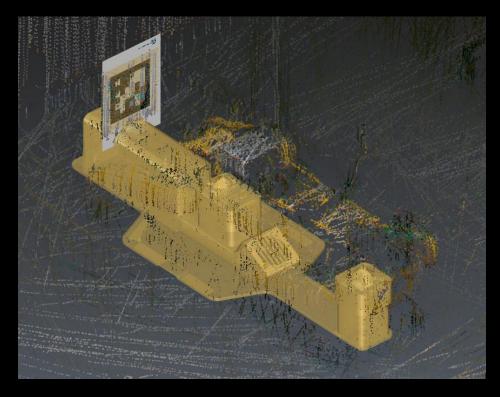
Following the instructions below, pick 3 points:

One at the back of the docking station One in front of the docking station One on the left side of base plate



- 6. As an output available are:
 - a. A projection of docking station
 - b. Properly placed Fiducial mesh

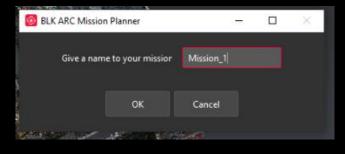




In case the projection is not placed correctly, undo the process (ctrl+z) and repeat the steps above until the result is satisfactory.

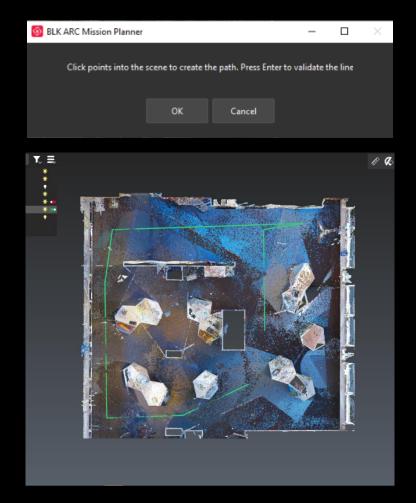
BLK ARC MISSION PLANNER – MISSION WITHOUT DOCKING STATION

1. Start BLK ARC Mission planner and define a name of the mission.





2. Start drawing point by point the path which the robot will follow. Remember to draw from start to finish. The first waypoint should be near the Fiducial. When the path is completed, confirm by clicking Enter.

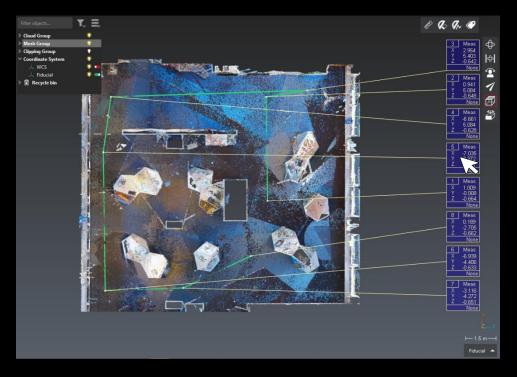


- **3.** When the path is drawn, you can define static scan poses on desired waypoints. Choose the types of scans required, remembering that it is possible to select multiple options.
 - a. None (default: walk through point)
 - b. Static Scan Low (10s scan)
 - c. Static Scan Medium (30s scan)
 - d. Static Scan High (60s scan)

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SIK /	ARC path plai	nning		_	\times	
	Choose whic	h kind of scans s:	hould be a	dded:		
	Add Static So	an Low (y/n)?				<u>e</u>
NY.	Add Static So	an Medium (y/n)î y			
	Add Static So	an High (y/n)?				
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		ОК	Cance	el		
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4. Select the labels for points where the BLK ARC should take a desired scan. Press Enter to finish.



- 5. At the end of the process, you will be prompted to confirm the choices or to restart the selection of the scans.
- 6. Once the path is confirmed, a message will appear with the approximate duration of the mission.
- 7. Lastly, save the *.json file locally on your computer.

BLK ARC MISSION PLANNER – MISSION WITH DOCKING STATION

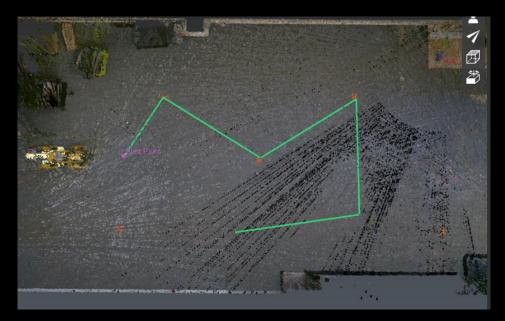
Start BLK ARC mission planner and define the name of the mission, name of the UCS and confirm, that the active UCS is related to docking station (y).

BLK ARC mission planner: project definition		_	×
Give a name to your mission	Mission1		
Give the UCS name which corresponds to	the fiducial to use: F	iducial	
Is the active UCS related to a docking stat	on (y/n) y		
ОК	Cancel		

Draw a path, point by point, remembering that the first waypoint will be placed automatically close to the docking station. Press Enter to validate.



Important: Do not close the path.



If desired, choose the type of statics scans to be performed and then specify their positions by clicking on the waypoints labels. It is possible to select multiple options.

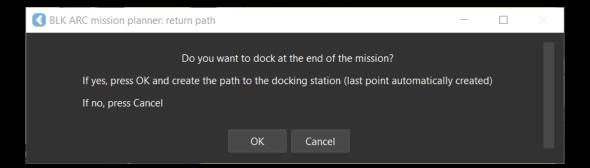
Available scan types:

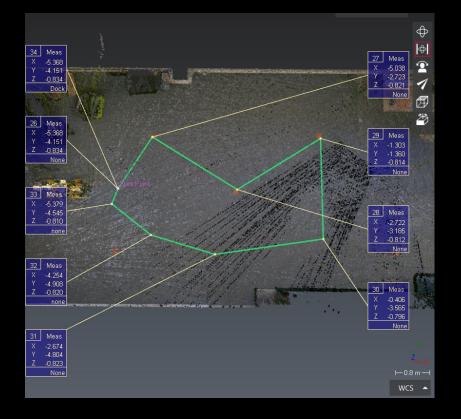
- a. **None** (default: walk through point)
- b. Static Scan Low (10s scan)
- c. Static Scan Medium (30s scan)
- d. Static Scan High (60s scan)

S BLK ARC mission planner: add setups − □	\times
Choose which kind of scans should be added:	
Add Static Scan Low (y/n)? n	
Add Static Scan Medium (y/n) ['] n	
Add Static Scan High (y/n)? n	
OK Cancel	

The window below will pop up – press ok to dock at the end of the mission, then create a path leading to the docking station.







Then, an information with the estimation of mission duration will appear. After pressing OK, you will be prompted to specify where to save the *.json file, select desired folder.

The window below will appear. Press OK if you want to export *.obj file as a reference model for the mission.

Important: Reference model is required to perform a mission with docking station.

BLK ARC mission planner: Export a reference model	_	×
Export a reference model in obj format (visible mesh require -If yes: click OK, and then the corresponding mesh	d)?	
-If no: click CANCEL		
OK Cancel		



EXPORT 3D MODEL (*.OBJ) FOR POSE OPTIMIZATION

BLK ARC-UI version 1.2.0 introduces the **Pose Optimization**, that allows the carrier to improve the quality of the navigation system and the procedure of locating the fiducial in the real world. It is necessary to upload an *.obj file in the correct coordinate system to use the feature. It is mandatory to locate the fiducial in the digital model and plan the mission in the same file to assure proper functioning. The *.obj file can be exported from a BIM model or can be based on a mesh model. For details see the following sections.

EXPORT 3D MODEL (*.OBJ) FROM BIM MODEL (*.IFC)

- 1. Import the IFC model into Cyclone 3DR.
- 2. In the BIM model, select all (and only) classes of the floor you need



- Create the UCS with BLK ARC Fiducial UCS script (see section "BLK ARC FIDUCIAL UCS METHOD 1: THREE POINTS (CAD / BIM)")
- 4. Create the path with BLK ARC Mission Planner (see section "BLK ARC MISSION PLANNER")
- 5. Once the mission is defined, DO NOT MOVE the model
- 6. Select the BIM model



7. Go to Extract menu, select Mesh and press From BIM



File	Home	View	CloudWo	orx Co	oord Sys	Clean	Extract	Surface N	/lodeling
유 우 Point	Cloud	Convert from	-7	Polyline	CAD Curve v	CAD Wire ¥	CAD Surface ¥	Line	
Measu	Group Fiducial re Group g Group			m Geom m CAD m BIM	etry				
	WCS Fiducial		* • * • *	- -	17	m BIM ense: Cyc	clone 3DR St <u>Op</u>	andard en Help (F1	

- 8. Select the BIM model
- 9. Go to File menu, select Export..., press Selected object and then File to export...

File	Home	View	CloudWorx	Coord Sys	Clean	Extract	Surface Modeling	Analysis	Texturing	Tank	Reverse Eng	Script	Report	
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10. Select *.obj as format file, add name and Save

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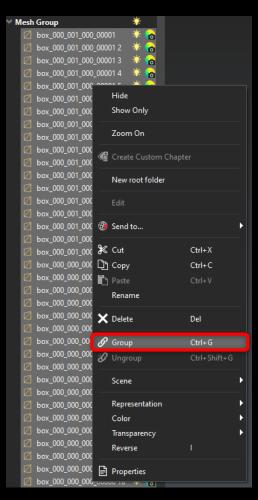


11. Before export make sure that the unit is set to **meters** (*m*) and that **Export in current UCS** is NOT selected

File unit	m 🔻
Export in current UCS	
ι	

EXPORT 3D MODEL (*.OBJ) FROM MESH

- 1. Import mesh model into Cyclone 3DR. Mesh can be created in HxDR from b2g file or in any other software
- Create the UCS with BLK ARC Fiducial UCS script (see section "BLK ARC FIDUCIAL UCS METHOD 1: THREE POINTS (CAD / BIM)")
- 3. Create the path with BLK ARC Mission Planner (see section "BLK ARC MISSION PLANNER")
- 4. Once the mission is defined, DO NOT MOVE the model
- 5. Select all and only the meshes you are interested in
- 6. Right click and press Group to create a unique mesh



7. Select the mesh





8. Go to File menu, select Export..., press Selected object and then File to export...

9. Select ***.obj** as format file, add name and **Save**

File name:		\sim
Save as type:	OBJ Format (*.obj)	\sim
∧ Hide Folders	AutoCAD DXF (*.dxf) FBX File (*.fbx) GL Transmission Format (*.glb) IFC File (*.ifc)	
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10. Before export make sure that the unit is set to **meters** (*m*) and that **Export in current UCS** is <u>NOT</u> selected

File unit	m 👻
Export in current UCS	

EXPORT 3D MAP (*.BYTES) FOR VISUAL INITIALIZATION

Coming soon!

This manual will be updated and made available as soon as it is available on the HxDR platform.



LEICA BLK ARC-UI



BLK ARC-UI is a browser-based user interface dedicated for operating BLK ARC Laser Scanner integrated by Leica Geosystems with robotic carriers, such as Boston Dynamics Spot robot.

How to access BLK ARC-UI on Spot

- 1. Connect from any device (smartphone, tablet, laptop) to Spot's WiFi network.
 - Spot CORE must be mounted and have installed BLK ARC-UI (detailed instruction can be found in the chapter *Installation*)
 - Operating system does not matter on the mobile device (Android, iOS, Windows)
- 2. Use any web-browser to access BLK ARC-UI (Safari, Chrome, Firefox) and type the address:
 - http://192.168.80.3:21002/ (if Spot's WiFi set to Access-Mode – please see Networking chapter)

Important: It is recommended to open and use BLK ARC-UI in a single tab. During operation, make sure that BLK ARC-UI is open on one mobile device at the same time.

It is recommended to use BLK ARC-UI in landscape orientation and on the iPad Pro 11-inch screen for the best user experience.



HOW TO USE BLK ARC-UI

The following instructions will guide you through the screens available in BLK ARC-UI.

Dashboard

1 – Status of connected devices:

For the robot, the battery status is displayed. If the icon is greyed-out it means that there is no device connected.

If the GNSS status icon is:

-Greyed out it means that there is no antenna available.

-If there is a red light – the antenna is connected but there is no connection established, -If the light is orange – the antenna is connected but the quality of the solution is weak. -If the light is green – the antenna is connected, and the quality of the solution is good. The number on the top right of the GNSS icon represents number of satellites the device is connected to.

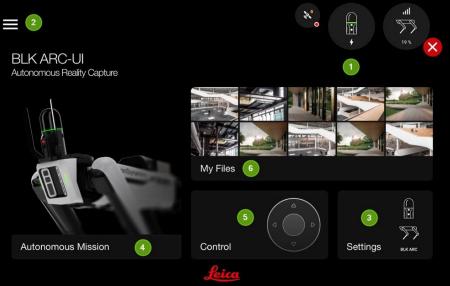
2 – Logs and BLK ARC-UI details can be accessed from the Hamburger menu.

3 – Settings - in this panel a user profile can be created. The active profile must contain the appropriate scanner + robot configuration and may contain credentials to an external WiFi network to transfer data to HxDR.

4 – Autonomous mission – this tool allows to upload, execute, and control your pre-planned mission for BLK ARC (detailed instruction can be found in the chapter *Offline mission planning*).

5 – My files – this panel contains all information about the data collected with BLK ARC and it allows to transfer / download / process / view / upload to HxDR.

6 – Control – this panel allows to control the BLK ARC laser scanner independently manually and/or robotic carrier.



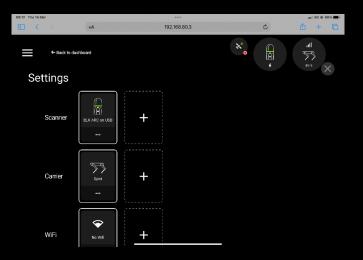


Settings (3)

In the **Settings** tab it is possible to create, edit and activate different options for the Scanner, Carrier and the WiFi.

Default settings:

- Scanner the BLK ARC, connected via USB,
- Carrier- the Spot Robot,
- No WiFi credentials are stored.

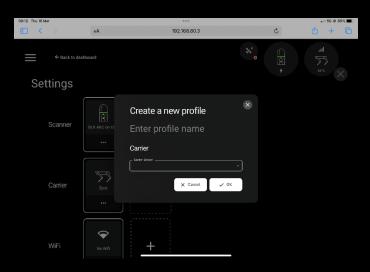


It is possible to change the type of connection of the scanner, by triggering the plus button in **Scanner** section and then selecting a different option of connection (it will require to mount an external WiFi dongle).

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In the Carrier tab, it is possible to define the model of carrier you are connected with.





To enable Internet connection on Spot CORE, it is necessary to use **an external WiFi dongle** that must be connected to the Spot CORE. The credentials of the available WiFi network must be defined in WiFi. Please check **Networking** chapter for more details.

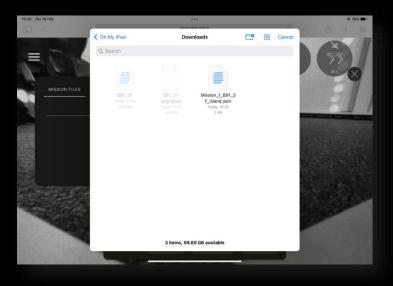
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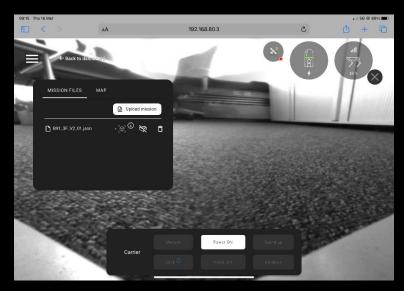
Autonomous mission (4)

Autonomous mission without GA03

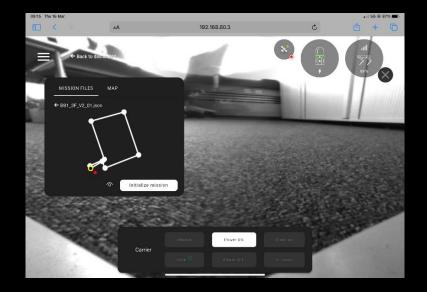
The predefined mission can be uploaded (*.json file) to BLK ARC-UI in this panel. Select **Upload mission** button and select the mission file from your local drive. All mission files are stored on Spot CORE. For detailed instructions on how to create a mission file please refer to **Offline mission planning** chapter.



Once the file is uploaded, choose the mission from the list. The preview of the selected mission will appear.

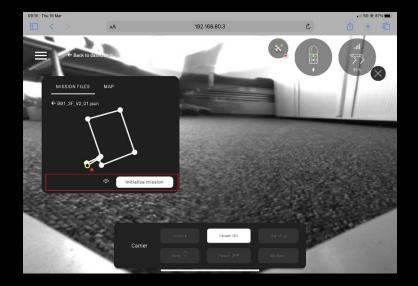






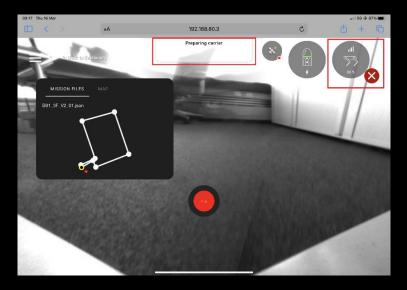
By default, each mission requires a continuous connection between BLK ARC-UI and the robot's WiFi. This means that every time you close the tab with BLK ARC-UI, lock the screen of your mobile device or disconnect from the robot's WiFi, the robot will sit down, and the mission will be interrupted.

Important: In controlled and safe environments (on your own risk), it is possible to turn on **Unobserved mode** by selecting the icon and run a mission where a connection between the robot's WiFi and the remote device is not required. When running mission in Unobserved Mode, the mobile device with BLK ARC-UI may be disconnected from the robot's WiFi after starting the mission. Once the mission is selected, with or without the Unobserved Mode enabled, simply select the **Initialize Mission** button to begin. After that, the robot will power on. The status of the mission is displayed at the top of the screen.

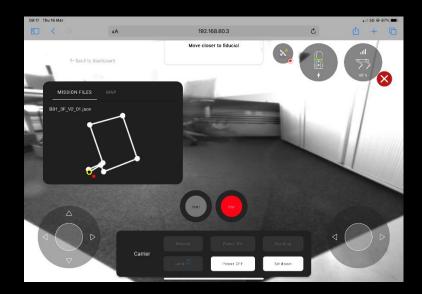




When the robot is running, the **E-Stop** is activated in the top right corner. For an emergency stop of the carrier, press, and hold the red cross icon. As soon as the button is released, the robot will sit down, and the mission will be aborted.



After powering on the carrier, the robot control panel appears. Use the remote joysticks to move the robot within the range where the fiducial can be detected.

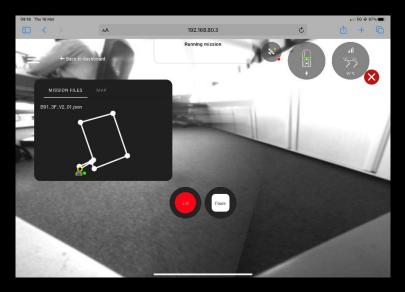




When the robot will detect the fiducial, the **Start Mission** button is enabled. Once the mission has started, BLK ARC will initialize the scan (yellow LED blinking) and start scanning while the robot completes the mission.



During the mission, the operator can **Pause** or **End** the mission. While the mission is paused, the **control panel** for the robot appears. The operator can manually move the robot and **Resume** the mission anytime. Please note, that in this case the BLK ARC module is continuously collecting the data.



In the mini map window, the red dot represents the position of the fiducial which hasn't been recognized yet. Once fiducial has been detected the dot changes its color to green. In the mission preview, the robot's current position is marked with a flashing blue dot. The planned trajectory is marked with white lines and dots. Yellow dots represent static scan positions. The next waypoint is marked with a black dot. The green part of the trajectory represents the part of the mission that has already been completed.

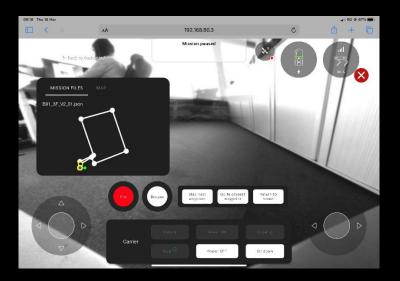


When the mission is paused, the user has the choice to navigate the robot using the joysticks if needed and utilize one of the following options:

1. Skip next Waypoint - the robot will skip the next waypoint and go directly to the folowing one. It is possible to skip multiple waypoints by selecting this function the desired number of times.

Important: If the waypoint includes docking the carrier, that action will also be skipped.

- 2. **Closest Waypoint** the robot will go to the nearest but not yet visited waypoint and continue the mission from there.
- 3. **Return to home** the robot will return to home to the point where the calibration was completed.



After selecting one of the options above, it is required to press **Resume** in order to continue the mission.

When the waypoint cannot be reached (for example there is an obstacle obstructing the waypoint), the robot will automatically skip it and go directly to the next one. Informing message will pop up on the screen.

When an obstacle is detected on the path, the robot will execute the Local Obstacle Avoidance functionality. It will attempt to plan an alternative path within +/- 3m from the original path and the current position of the robot.

Important: The Local Obstacle Avoidance does not detect dynamics or moving objects.

If that will not be possible, the carrier will stop and induce the **Return to Home** command after 10 seconds. In case this is not the desired behavior, the operator can **Pause** the mission and remove the obstacle or manually navigate the robot around it, then the mission can be resumed and will continue as planned, or **End** the mission.

Once the mission is completed, a feedback message will appear on the screen of the mobile device, the robot will sit down and turn off the motors.



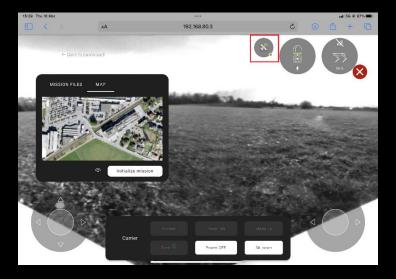
Autonomus outdoor missions - GNSS

The BLK ARC-UI version 2.0.0 introduces outdoor missions with touch2go navigation, using combination of GNSS signal with GrandSLAM trajectory.

To run such missions the Leica GA03 GNSS antenna and a mobile device displaying the BLK ARC-UI with Internet connection are required.

The GNSS connection must be estabilished to be able to run an autonomus outdor mission Connect the antenna to your SpotCORE and observe the status icon on the BLK ARC UI:

- if the lcon is greyed out the antenna is not available
- if the icon has a red light the antenna is connected, but there is no GNSS connection estabilished
- When the light turns orange, it means that GNSS connection has been estabilished, but the quality of the solution is weak.
- When the light on the status icon turns green the quality of the solution is good.

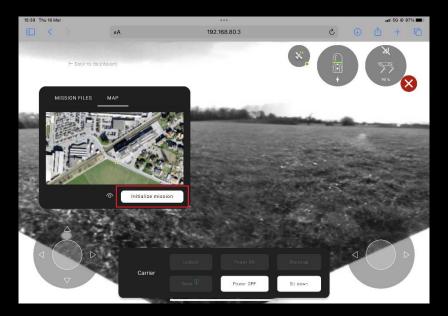


Ensure the best quality of the solution (green icon) before starting calibration of the GNSS module. To do so, move the carrier to best environment possible (open sky area). That will ensure the best mission performance.

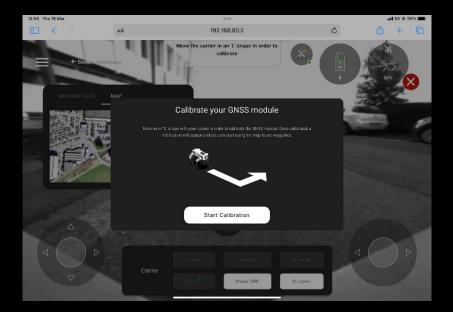
It is important to keep in mind that well performed calibration is a key to a succesfull autonomus outdoor mission.



To start the mission, open the Map tab and press the Initialize mission button.

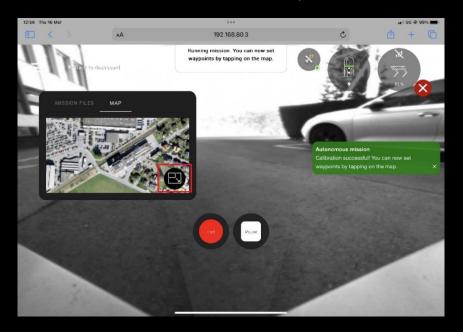


Press the **Start** button (the button will be available only when the GNSS connection has been estabilished and the status is good (green Icon). The scanner will initialize and then you will be prompted to calibrate the GNSS module. Move the carrier in an L – shaped path.





Once the calibration is completed, it will be possible to tap on the map to create waypoints. It is possible to maximize the Map tab for better path planning experience.



After setting a waypoint on the map, an action must be specified between:

No action

Static scan

If static scans are desired it is possible to define their types (low, medium, high).

To delete a waypoint - long press on the desired waypoint.

Important: You can delete only one waypoint at a time, starting from the one most recently created. It is not possible to delete a waypoint that is already being approached by the carrier, but it is possible to skip it.

It is possible to **Pause** or **End** the mission at any point. After pressing the **Pause** button, the following options are available:

- 1. Skip next Waypoint the robot will skip the next waypoint and go directly to the folowing one. It is possible to skip multiple waypoints by selecting this function the desired number of times.
- 2. Go to closest Waypoint the robot will go to the nearest nearest but not yet visited waypoint and continue the mission from there.
- 3. **Return to home** the robot will return to home to the point where the calibration was completed.





After selecting one of the options above, it is required to press **Resume** in order to continue the mission.

The **Unobserved mode** mentioned in the **Autonomus Missions** paragraph, works and aplies the same logic with the Autonomus Outdoor missions. It is important to remember, that this function should be used strictly in controlled and safe environment, and it is at user's risk to make that judgement.

In the **Map** window, the robot's current position is marked with a flashing blue dot. The planned trajectory is marked with white lines and dots. Yellow dots represent static scan positions. The next waypoint is marked with a black dot. The green part of the trajectory represents the part of the planned path, that has already been completed and the blue line represents the actual shape of the path the carrier had walked.





Use the following gestures to control the map:

- Press and slide with one finger to move the map in 2D plane,
- Use the pinch fingers gesture to zoom in and out,
- Use two fingers to rotate the map.

When the waypoint cannot be reached (for example there is an obstacle obstructing the waypoint), the robot will automatically skip it and go directly to the next one. Informing message will pop up on the screen.

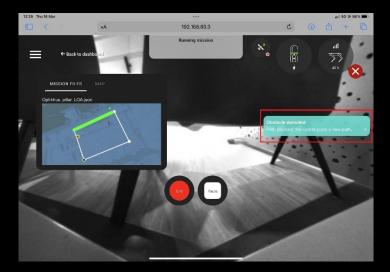
When an obstacle is detected on the path and it cannot be avoided within small distance and random walk, the robot will stop and if within 10 seconds the user will not take any action, the carrier will execute the **Return to Home** command. In case this is not the desired behavior, the operator can **Pause** the mission and remove the obstacle or manually navigate the robot around it - then the mission can be Resumed and will continue as planned or **End** the mission.

The user can end the mission at any moment by pressing the **End** button, a feedback message will appear on the screen of the mobile device, the robot will sit down and turn off the motors.

Improved Local Obstacle Avoidance

If during the autonomous mission an obstacle is detected on the planned path, the robot will attempt to find an alternative path to get to the next waypoint, in a more efficient and intelligent way than previously.

The new solution uses live streamed BLK ARC LiDAR data to plan new path around an obstacle, in the real time. The feature bases on a local environment, it means that the new trajectory will be planned only within 3 meters from the original path and from the current position of the carrier.



When the carrier reaches an obstacle, it will stop, and a notification will pop up on a BLK ARC-UI. The robot will proceed planning the new path and if within 5 attempts it will not be able to find a way around, the **Return to Home** command will be triggered. Before it will be executed the user has 10 seconds to take an action to avoid that. This can be pausing the mission and manually walking the



carrier around the obstacle, after that the mission can be resumed and will be continued as planned. Otherwise, the carrier will proceed returning to the starting point of the mission.

The upgraded Local Obstacle Avoidance functionality is curently not enabled for the **Outdoor Autonomus Mission**, but the previous solution still supports it.

Return to Home command

The BLK ARC-UI version 2.0.0 introduces new command – Return to Home. The user can execute it during any autonomus mission.

Return to home practically means that the carrier will go back to the place where the the mission has begun (beside the Fiducial or where the Visual Initialization succeeded). For the Autonomus Outdoor Mission it is the end of the calibration path (L), for missions with docking station – the robot will go back and sit on the docking station.



The **Return to Home** command will be executed automatically when the carrier will reach an obstacle on its path and will not be able to avoid it.

In more complex missions (with many loops) the carrier will follow the shortest path to return. For simple missions, where the path does not cross, the robot will revisit all the waypoints before reaching Home.

In cases where the E-Stop has been triggered during a mission – to perform the **Return to Home**, it is necessary to first press the **Power ON** button and then **Return to Home**, otherwise the mission will be aborted.

BLK ARC Pose optimization

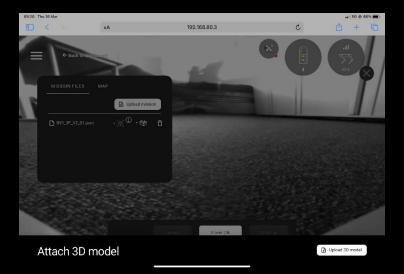
BLK ARC-UI version 1.2.0 includes additonal pose optimization during autonomous mission, that allows the user to import an additional *.obj file to optimize the current position of the carrier. This 3D model will improve the navigation of the robot during the autonomous missions and minimize the misalignment caused by inaccurate fiducial placement and/or its inaccurate detection when the mission starts. For detailed instructions on how to export an *.obj file in the correct coordinate system, please refer to the **Offline mission planning** chapter.



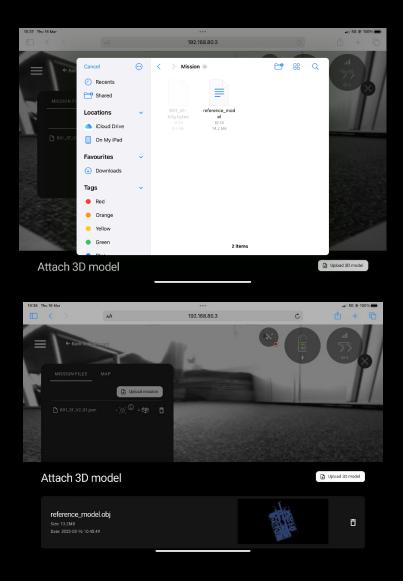
Once 3D model is exported, attach uploaded earlier model by pressing the icon marked below, in the **Autonomous mission** panel.



A side menu will appear on the bottom of the screen. In this menu you can either select a 3D model by clicking on the proper row or upload a new one. Once the model is uploaded, select the desired file by clicking on it. It is possible to use the same model for multiple missions, if they were planned on the same file. You can also navigate into preview of the 3D model.





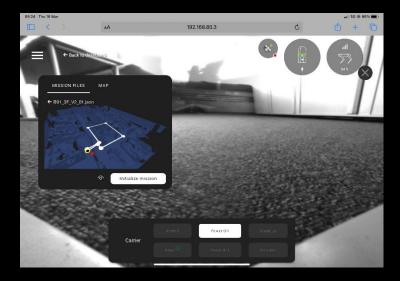


Once the 3D model is attached to the mission, the icon will change. To detach the model, you can press the icon twice. The icon will represent the current status.





Select the mission with the 3D model attached. **Mission visualisation** tab will show the preview of the mission aligned with the attached 3D model. If the map is not correctly aligned to the 3D model, check if the *.obj was exported correctly and if proper *.obj file is attached. **Initialize mission** in order to begin capturing the data.



During the mission, it will always be possile to pause it, skip the waypoint or go to the closest waypoint.

Important: Logs downloaded after a mission with the pose optimization will include the last *light version of a point cloud* used for pose optimization during last mission. In case any support is required, sharing logs including this data will allow to troubleshoot in case of unexpected behaviour.

BLK ARC Visual initialization of autonomous mission

BLK ARC-UI version 1.3.0 allows to start a mission without a Fiducial being physically placed on site. For repetetive missions, the user can benefit from previously captured *.b2g file to automatically create a 3D map (*.bytes files) of the enviornment within the HxDR platform. Then it is possible to upload this 3D map file to the BLK ARC-UI and use it as a digital representation of the environment in which BLK ARC scanner can localize itself to start an autonomous mission.

Important: Any *.b2g file coming from BLK ARC but also BLK2GO can be used for the 3D map file (*.bytes) creation.

For detailed instructions how to prepare 3D map file (*.bytes) and corresponding mission files please refer to the **Offline mission planning** chapter.

Important: Enabling the Visual Initialization is possible only together with the **Pose optimization**. It is highly recommended to use 3D model (*.obj) and 3D map (*.bytes) out of the same *.b2g file downloaded and unchanged, directly from HxDR platform. If the 3D model is detached, the 3D map will be automatically detached too.

Below is the instruction on how to execute the mission using the **visual initialization** for autonomous mission in BLK ARC-UI.



First - load mission file (*.json) and corresponding 3D model (*.obj) for pose optimization. Make sure that both of the files are attached as shown on the picture below.

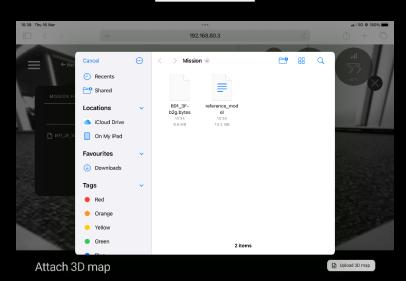


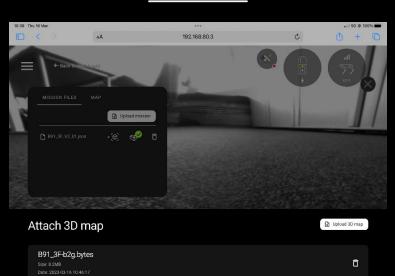
Press marked icon in order to upload & attach a 3D map to your mission file. **Note**: Icon for attaching 3D map is disabled if 3D model is not attached yet.



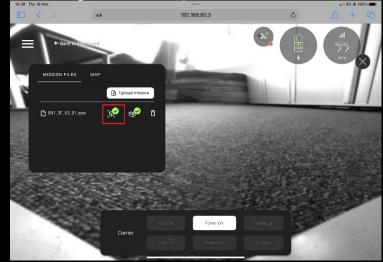










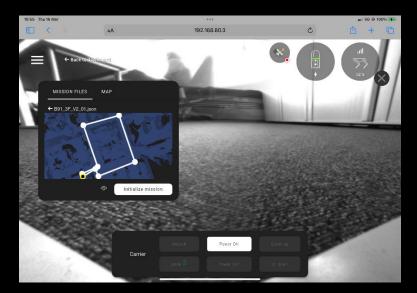


Once 3D map is attached, the green icon will represent the current status.

It is possible to use the same 3D map (*.bytes) for multiple missions, as long as the missions were planned using the same files and cover the same and complete area.

Click twice on the visual initialization icon in order to detach 3D map.

Once all the files are attached, select the mission file and initialize the mission.



Place the robot near the first mission point. It is crucial that the front of the robot, precisely - the detail camera of the BLK ARC, is pointed towards the scene that contains visual features which coincide with the features within the scan file (*.b2g) used for creating the 3D map.

After pressing the start button, the mission will begin as usual, i.e. the robot as well as the scsanner will start additionally triggering a picture which will be used for visual initialization, after the initialization succeeded, the initial pose optimisation will be calculated and the mission will continue. In case the visual initialization fails, rotate the robot or move it around the first mission points to improve the vision of the scene and repeat.



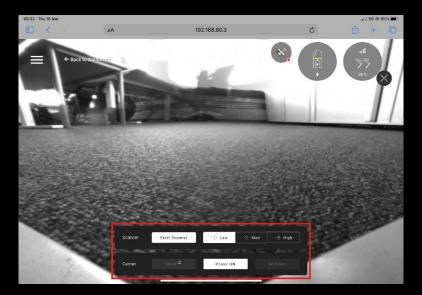
Important: The quality of the Visual Initialization depends on the quality of the image taken at the beginning of the mission as well as on the quality of the 3D map. This means that the best possible and the same lighting conditions should be ensured when collecting a scan for the 3D map and during the visual initialization.

In case the visual initialization fails after several attempts, it is still possible to run the same mission with the traditional method of starting the mission using Fiducial.

Important: Logs downloaded after a mission started with the visual initialization will include black and white pictures used for initialization of the mission as well as last *light version of a point cloud* used for pose optimization during last mission. In case any support is required, sharing logs including this data will allow to troubleshoot in case of unexpected behaviour.

Control (5)

In addition to the mission planning panel, BLK ARC-UI allows the manual control of the robot and BLK ARC. **Start** the scanner and / or carrier to collect the data and use the **remote joysticks** to control the robot's motion.

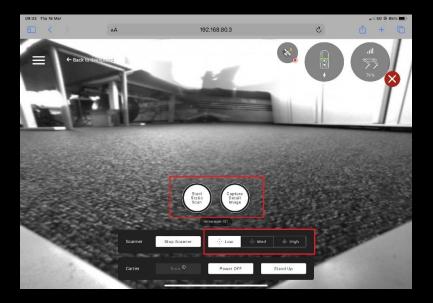


Important: From the control panel, the scanner and robot can be operated independently. In this mode, BLK ARC does not provide the carrier with any navigational support, so this control panel can only be used to operate the robot.

If a docking station is available, the control panel also allows to dock and undock the robot. The buttons are enabled only when the robot is close to the docking station and can detect it.



To initialize a scan while the carrier is controlled manually the following workflow is recommended – start the carrier and move it to a standing position, move the carrier using joysticks to a place sufficient for scan initialization, start the scanner.



After the scanner has been initialized, it is possible to trigger static poses manually in the following modes:

- Low 10 sec
- Med 30 sec
- High 60 sec

Please predefine the desired duration of a static scan before each static scan.



Make sure there is enough space around the robot during the static scans as the robot will move to the tripod position. During a static pose, the manual control panel will disappear to prevent unintentional movement commands. The countdown till the end of the static scan will be displayed. During tripod pose, the robot's collision avoidance is working and in rare cases, when collision is



detected, the robot may move. In such situation the static pose should not be used by the user in post processing. The dynamic scan collection will remain.

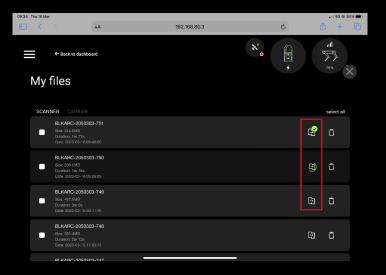
Once the static scan is complete, BLK ARC continues to collect the point cloud in dynamic mode and the operator can continue to manually navigate the robot.

The scanner does not take any detail images at the very beginning and at the very end of the static scan. Capturing detail images, is possible from a control panel using the **Capture Detail Image** button.

My Files (6)

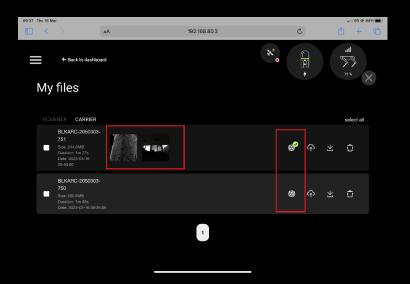
In My Files panel there are two tabs available:

• SCANNER –list of all scans available in the internal memory of BLK ARC module. To download / process / upload to the cloud select transfer icon. During the transfer the progress circle appears. Select delete icon to delete the scan permanently from the scanner Please make sure to trigger the transfer of the scans from Scanner to Carrier only once the scan is finished.



• **CARRIER** –list of all scans that has been transferred from the scanner to the carrier. Once the file is transferred to carrier, it is possible to trigger the processing which will extract detail images, export e57 point cloud and will allow for further transfer of e57 to USB stick / upload to HxDR or download via browser.





On the left side it is possible to find detailed information about each scan, such as:

- Name of the scan
- File size (b2g)
- Duration of the scan
- Serial number of the connected device
- Date and time of a capture

It is recommended to process one by one or a maximum of 2-3 files at the same time. Deleting a scan from a Carrier tab will delete the scan file only from the Spot CORE.

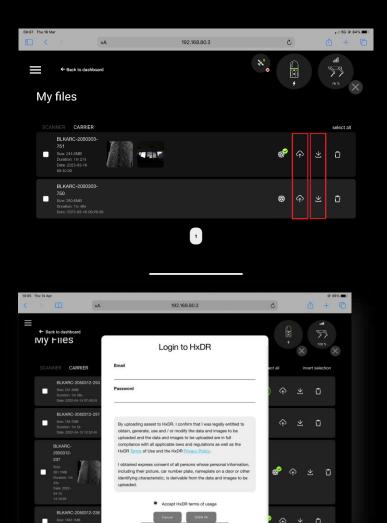
Once the file is available on the Spot CORE (b2g and e57) select **Upload to HxDR** icon to start uploading to the cloud server. For the first upload, the HxDR login page will pop up, enter your credentials, and continue.

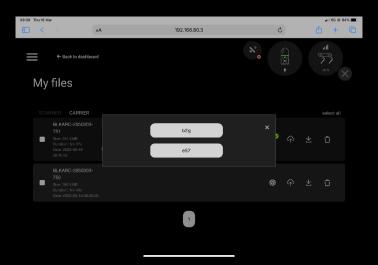
It is recommended to upload b2g files to HxDR for the best quality of a mesh.

BLK ARC-UI provides the option to download the b2g or e57 files (select the **Download icon**)

- via browser using a WiFi connection between the robot and a mobile device on which the BLK ARC-UI is open
- via USB from Spot CORE directly to the USB memory stick connected to the Spot CORE USB-A port. The USB stick must be connected to the Spot CORE before turning on the robot

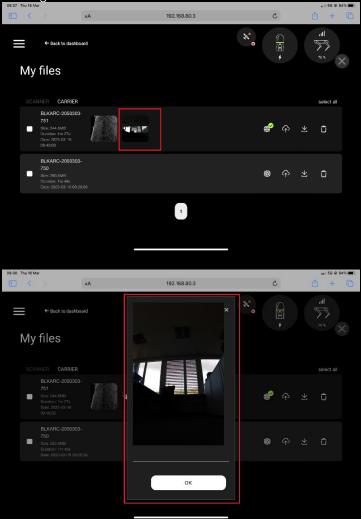






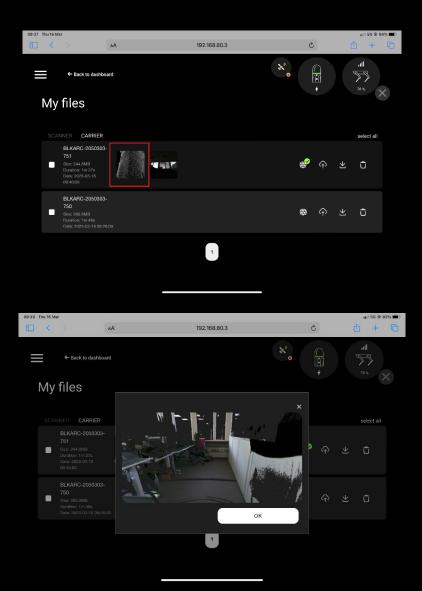


Once the b2g file is transferred from Scanner to Carrier and processed on Spot CORE, and if the detailed camera images have been captured with BLK ARC, the thumbnail will appear, making it possible to preview the image in BLK ARC-UI.



If the e57 file is available on Spot CORE, the point cloud preview is available in the BLK ARC-UI. Select the point cloud thumbnail on the left. This will open a window with a 3D preview of the colored e57 file.





On the touchscreen, use the following gestures to navigate in the point cloud:

- use two fingers to rotate the point cloud freely
- use the swipe gesture with one finger to navigate through the point cloud
- use pinch finger gestures to zoom in and out of the point cloud.

Using the mouse to navigate, use the following commands:

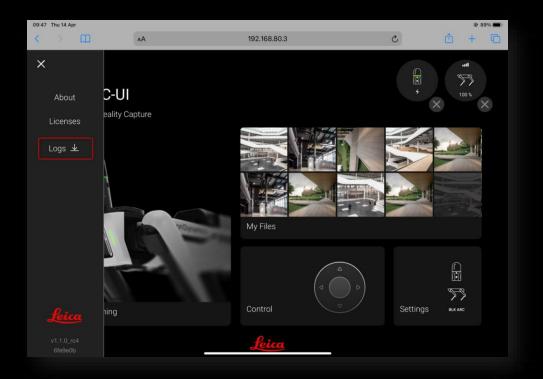
- left mouse button for panning
- right mouse button for rotating
- scrolling the mouse for zooming.



LEICA BLK ARC-U

STARTING, STOPPING THE SERVICE AND SAVING LOGS FROM BLK ARC-UI

Logs can be copied directly from BLK ARC-UI. Select the **Hamburger menu** \rightarrow Logs. Download all logs and share with the support team.



When contacting support team, please also download and share the logs from BLK ARC module (by connecting via WiFi to BLK ARC module directly and accessing 10.1.1.1 in the web browser).

If requested by support for troubleshooting:

The BLK ARC-UI service can be controlled by the Portainer.

Access the Portainer, navigate to Stacks and click on the previously generated stack named BLK ARC-UI. In the menu-bar of the container you can either control the service (start/stop/restart) or generate a log file using the following commands:



- **Restart**: Restart the software in the case an unexpected error occurred (similar to reboot Spot CORE).
- Start, Stop: Start or stop BLK ARC-UI. Stop can be used when the service is no longer required.
- **Document symbol**: Access the logs of the software. Once you open the logs, select all, copy and paste into empty text document. To ensure that all important logs will be attached, it is recommended to change Lines value into +100000 in the Log viewer settings. Logs should be copied for all Container that are running on the Portainer.

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BLK ARC DOES NOT CONNECT VIA CABLE

Situation: BLK ARC-UI is available, BLK ARC laser scanner is powered on (solid green LED ring), but BLK ARC-UI has no connection state with BLK ARC module (upper right corner in BLK ARC-UI)

 Make sure both cables (power cable and USB) are connected. If you reconnect cables on a powered Spot, be sure to reconnect the power cable first and later USB - power must be supplied first; the USB cable also acts as a button press to start the device.

Refresh the BLK ARC-UI, wait 10 seconds and check if that solves the problem.

2. In BLK ARC-UI, go to Settings and make sure that the active profile is set to **BLK ARC** device and **USB** connection type. Restart the robot.



Refresh the BLK ARC-UI, wait 10 seconds and check if that solves the problem.

3. Restart Stack file on Portainer (or all BLK ARC-UI containers). Refresh the BLK ARC-UI, wait 10 seconds and check if that solves the problem.

BLK ARC-UI DOES NOT REFRESH

Situation: BLK ARC-UI is not displaying updated information, such as a live preview of the trajectory status during a mission.

- 1. Make sure that the WiFi connection between the mobile device with BLK ARC-UI is stable with robot's WiFi.
- 2. Refresh the page with BLK ARC-UI in the web-browser.

BLK ARC-UI SOME BUTTONS ARE NOT RESPONSIVE AS EXPECTED

It is recommended to only operate BLK ARC-UI from one mobile device at a time. Also, close any other tabs opened in the browser.

UPGRADING FIRMWARE OF BLK ARC MODULE

It is recommended to always do a restart of the system after upgrading the firmware of BLK ARC module and BLK ARC-UI (Spot, Spot CORE, BLK ARC).

BLK ARC-UI AND TIME SYNCHRONIZATION ISSUE

If this issue happens, please restart Stack file on Portainer.



"RUN MISSION" BUTTON BLOCKED BY CARRIER PANEL (CHROME BROWSER)

Go to Chrome browser's settings and change the **Default site view** to **Desktop**.

UPLOAD TO HXDR FAILS

If upload to HxDR fails after login:

- Try again to upload the scan
- If the upload does not start, please restart the stack.

If ongoing upload to HxDR gets stuck:

• If the process is blocked and does not progress, please restart the stack.



LEICA BLK ARC-U

INTRODUCTION

The BLK ARC is a mobile device that uses SLAM technology, which means that best practices that affect the way the device captures its surroundings will ensure the best data capture results.

Check out below the best practices which should be followed, when using the BLK ARC on Spot.

BEFORE YOU START

Make sure all your hardware is running the latest and compatible versions. The latest installers can be found at myworld.leica-geosystems.com. The release notes describe all compatible necessary components.





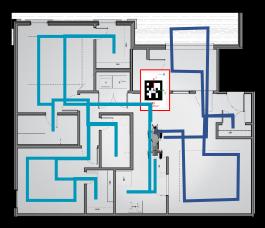
BEFORE MISSION PLANNING

• Can a single mission cover the entire area?

Keep scan/mission time in mind. Missions should not be longer than the typical scan time. Hours are too long! Divide the mission into several parts if necessary.

The same fiducial can be used in multiple missions.

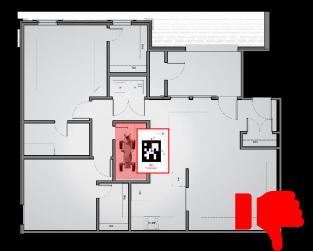
Ensure overlap between paths/scans for good post-processing registration.

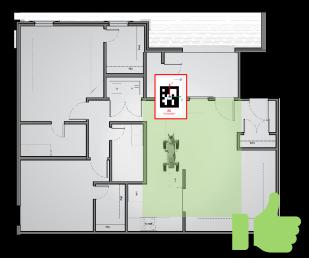


Where is the best place to put a fiducial? = Where is the best place to initialize a BLK ARC scan?

The scan initialization (moment when BLK ARC LED is blinking yellow when starting a scan) is a crucial step in data collection. It will be performed nearby your fiducial, therefore consider placing it in a SLAM-friendly place.

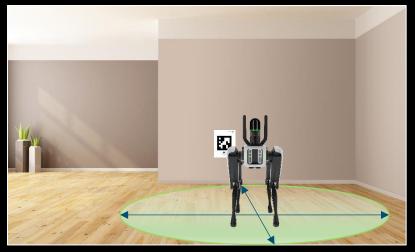
Keep in mind field of view and minimal distance for lidar.





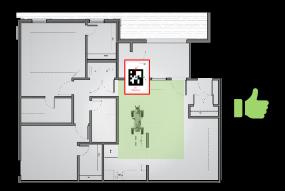


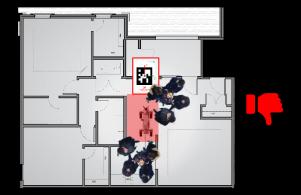
For Spot it does not matter which of the cameras is used to detect a fiducial but consider detecting it with the backside camera especially when fiducial is placed in a corner.



Thanks to that BLK ARC will be positioned a bit further away from walls and possible obstacles, which will allow for capturing good quality data for better SLAM initialization. Please note that for BLK ARC LiDAR the minimum measuring distance is 50 cm.

To ensure best possible data capture results, start with providing best environment for the initialization. Make sure that the device is stable, the robot is not moving and there are no people standing or moving around close to the BLK ARC during initialization. Otherwise, the field of view of the device may get blocked and it will not be able to collect enough information for successful SLAM initialization.





The initialization can take up to 30 seconds. Once LED turns green, the device is ready to be moved, and robot can start walking.

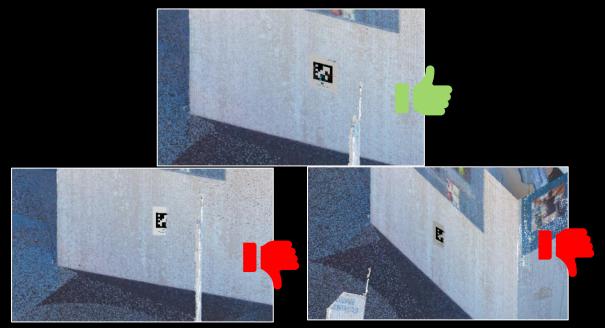
If BLK ARC cannot be initialized, due to unstable position or insufficient number of features around the initialization process will be aborted, and the LED will turn yellow. In such case, restart the device, correct the position, and then re-try the scan.



MISSION PLANNING

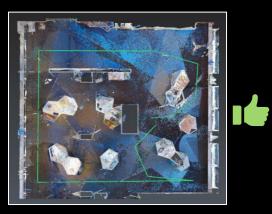
• Fiducial fitting – BLK ARC Fiducial USC script

Make sure the plane of the fiducial aligns well with the plane of the wall and properly defines the UCS.



• Draw obstacle free path – BLK ARC Mission planner script

There is no limitation to the length between 2 waypoints. Avoid waypoints in tight spaces or very close to glossy or transparent elements. Remember about some limitations of Spot's collision avoidance.









• Does the mission need to start and end in the very same point?

No. This can be considered a good practice for re-observation or other reasons such as keeping the Spot in one place where it rests.

WHILE SCANNING

GrandSLAM is a key to your successful autonomous mission

When running autonomous mission, the robot is being guided with trajectory from our SLAM solution. It means that the better the SLAM result, the better autonomous mission performance, therefore it is crucial to understand and respect all best practices related to SLAM. BLK ARC is using GrandSLAM technology which is a combination of Lidar SLAM, IMU measurements and VIS (Visual Inertial System) tracking.

The GrandSLAM requires good lightning conditions and visual features present in the panoramic camera's field of view. If one of the requirements is not fulfilled, the VIS will be switched off and the device will run in Lidar SLAM mode only.

The accuracy and noise range will not be affected, however for the most reliable SLAM performance and especially in SLAM challenging environments (like mines, tunnels, large outdoor areas, long corridors) it is highly recommended to keep device running in GrandSLAM mode. By default, each scan starts with the GrandSLAM, but once a fallback to the Lidar SLAM occurs, the device will not be able to retrieve the GrandSLAM within that scan.

Please note, that the same logic and behaviour applies to the handheld BLK2GO device.

Considering the GrandSLAM technical details mentioned above, it is recommended to:

Do not stress the IMU, that means move the robot as gently as possible when collecting data with the BLK ARC.





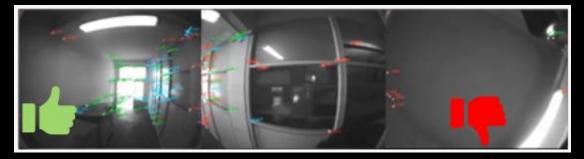


Keep the Lidar's field of view clear, so it can measure as much geometrical information as possible from many different directions.



Ensure the best possible lighting conditions while collecting data. If working in a dark environment, consider mounting additional artificial light source on the robot.







• Remember about safety



Spot can collide with people or objects. Operator and anyone nearby should assume that Spot may move unexpectedly at any time. Use Spot only in areas where a fall or collision will not result in an unacceptable risk.

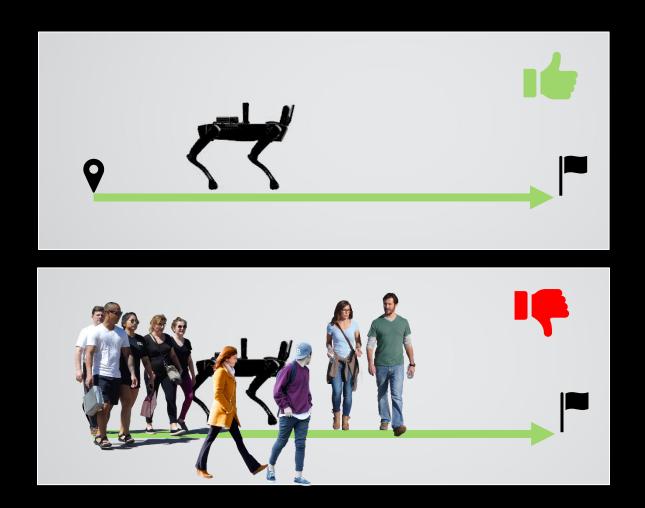
The following conditions can hamper the robot's obstacle detection system, which may result in collisions:

Very thin obstacles	< 3 cm in thickness. For example, ladders and tripods.			
High contrast environments	Spot's perception system has difficulty with high contrast environments such as very black materials against very bright backgrounds.			
Clear materials	Spot cannot see transparent materials and may crash into glass doors and windows.			
Short objects	Spot may step on paint cans, buckets, and other objects shorter than 30 cm even with obstacle avoidance enabled.			
Moving objects	Spot cannot predict trajectories of moving objects. Do not operate Spot around moving objects such as vehicles, children, or pets.			
Elevated obstacles	Do not walk Spot under ropes, tables, scaffolds, or low-hanging but elevated obstacles. These can collide with Spot or its payloads.			
Inadequate lighting	Spot requires sufficient lighting to function properly. Even in well-lit environments, shadowy areas may be too dark for Spot to detect obstacles.			



• Avoid following the robot too close

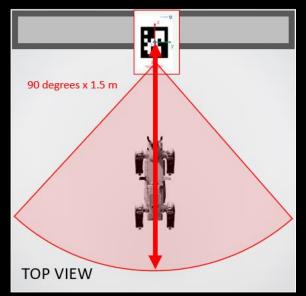
Beside safety aspects, moving objects/people close to the BLK ARC can cover field of view of the cameras and the LiDAR system what naturally causes more challenging conditions for SLAM. To ensure best point cloud quality, minimize the possibility of people walking by, as much as possible. As the Local Obstacle Avoidance function uses live streamed LiDAR data, moving people or objects too close to ARC may hinder the process of planning a new path carried out by the robot.





STARTING MISSION WITH FIDUCIAL

• Ensure good lightning conditions and position the robot within the range to detect a fiducial.



VISUAL INITIALIZATION OF AUTONOMOUS MISSION

• Ensure good light conditions when capturing reference scan and when initializing a mission.

The visual initialization is using images, so it is important to make sure the light conditions are good during:

- capturing a reference scan (*.b2g) which will be used for 3D map creation within HxDR platform
- executing visual initialization to localize robot when starting a mission.

If artificial lights are available, make sure to turn all the lights on. It is vital to have the same source of light on when capturing reference scan and starting visual initialization. If working with natural light only, the best results will be achieved if the weather conditions are

If working with natural light only, the best results will be achieved if the weather conditions are similar. A good practice would be to capture the data during the same time of the day, if mission is outdoor.

• During initialization the BLK ARC needs to see meaningful scene.

When starting a mission with visual initialization, the BLK ARC will capture images with detail camera and use them for re-localizing inside 3D map prepared earlier based on scan (*.b2g file).



Therefore, it is important to point the camera of BLK ARC towards a scene which contains many visual features and where these features are spread around, rather than placed on one single plane in 3D space. That will ensure highest success rate for visual initialization.

Important: Pointing the camera camera towards a source of light will make the image partially over or underexposed. Try to avoid it.



Well exposed image and with non-planar visual features will make visual initialization more successful.





AFTER DATA CAPTURING

• Re-observation for reducing SLAM drift in post-processing

If you are scanning in a harsh environment where SLAM drift can occur, remember to revisit the same places during the scan, so that the re-observation can be calculated in postprocessing. Instead of having a large loop, it is better to plan path to have medium sized loops that cross each other with significant overlap.

