RELAR

REmote Learning & examination based on AR

Guidelines for using the HMT-1 in learning environments

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1. Project Abstract

RELAR project aims to create a crisis-proof resilient maritime VET ecosystem by enabling remote learning and examination using Augmented Reality. The project is driven by a consortium formed by European VET organizations and HEI and will tackle all the deficiencies unearthed by the COVID-19 crisis focusing on transferring the expertise and knowledge of industrial organizations in improving security, safety and efficiency by empowering frontline connected workers with remote technology.

The maritime VET education ecosystem has to become more resilient to crisis and improve his adaptation capacity to forced shifts imposed by force majeure. Being tightly linked to other ecosystems having a major role in economy and in society as a whole (port ecosystem, national, European and international education ecosystem) maritime education has to be capable of absorbing social shocks generated by crisis situations and to ensure the continuity of the learning process.

The strategic partnership addresses key challenges of the maritime and port education ecosystem caused by structural change due to new digital technologies. It focuses on the adoption of augmented reality tools to improve learning outcomes.

Over the last decade, sensors enabled telemetry to connect devices, products, customers with Industry 4.0. While Industry 4.0 promises a wide implementation of automation, in most enterprises, operations are a set of tiring linear steps—slow, sometimes inaccurate and inefficient. In all this, front-line workers have been standing on the side lines for the last 20 years, watching and waiting.

The paradigm shift with Industry 5.0 is where the frontline worker is now in the center of things—machines, methods and workflows, and the technical management level is able to connect with him in a seamless manner.

The project will mirror the new paradigm “expert - frontline worker” proposed by Industry 5.0 concept to a next-level “teacher - student” paradigm for vocational education and training. Teachers will wear the augmented reality device for examining the students remotely by evaluating the quality of the instructions students gave. Students will enhance their technological skills and hands-on experience by using the same augmented reality device and executing tasks being remotely guided by the teacher. Both teachers and students will have the roles of expert or frontline worker depending on the objective: examination of learning.

2. Overview

The main concept of our work focuses on introducing Assisted Reality into the learning and examination context in maritime TVET. In this context the “teacher-student” paradigm for vocational education and training can be conceived as

- The teacher wears the AR device, and the student guides him/her through a variety of tasks. The teacher evaluates the quality of the instructions given.
- *The student wears the device and completes various tasks which may be outlined in direct communication with the teacher (via the AR device) and/or laid out in appropriate documents already present in the device, or accessed via QR codes.*
- *The complete student-teacher interaction can be video recorded from the AR device and subsequently evaluated.*
- Students will enhance their technological skills and hands-on experience by using the same Assisted Reality device and executing tasks being remotely guided by the teacher.

Both teachers and students will have the roles of expert or frontline worker depending on the objective: examination of learning. To achieve this, a common architecture and framework is implemented which can guarantee interoperability, scalability and sustainability of remote learning. A schematic representation of the proposed system is presented in Figure 1.

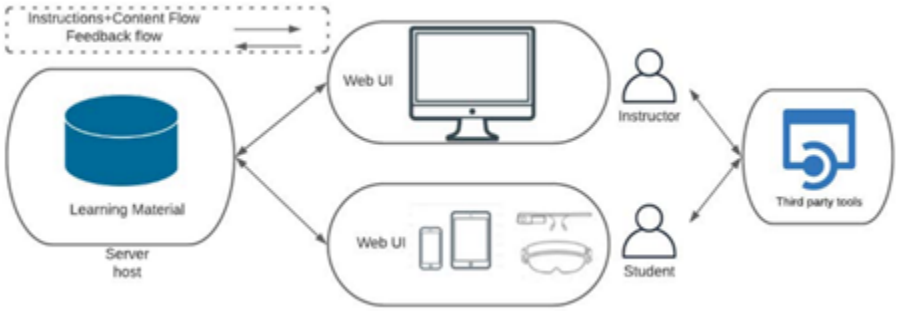


Figure 1

At a high level the main tasks the framework needs to support include video calling, document navigation, guided workflow, mobile forms and data visualization. More specifically the architecture has to support functionalities such as multimedia instruction authoring and storing, task selection and execution, feedback and assessment of performance.

3. Technical Introduction

This document outlines the main guidelines for the RELAR project. It details the main ways for sharing content in an educational environment between instructors and students. The purpose of the document is not to replace the HMT-1 official documentation, but to provide guidelines as to how Assisted Reality and specifically the HMT-1 can be used in this specific context.

In the educational environment the main needs that have emerged after consultations with end users include,

1. **Share data FROM endpoint TO the HMT-1** - i.e., how to send various types of files (DOC, PDF, PPT etc) from one endpoint (e.g. a computer) to the HMT-1.
2. **Share data FROM HMT-1 TO an endpoint** - i.e., how to send files (photos and videos) taken from the HMT-1 to another endpoint (e.g. a computer).
3. **Leverage the use of QR Codes** - i.e., how the HMT-1 user can easily scan appropriate QR codes and automatically open files and/or URLs.

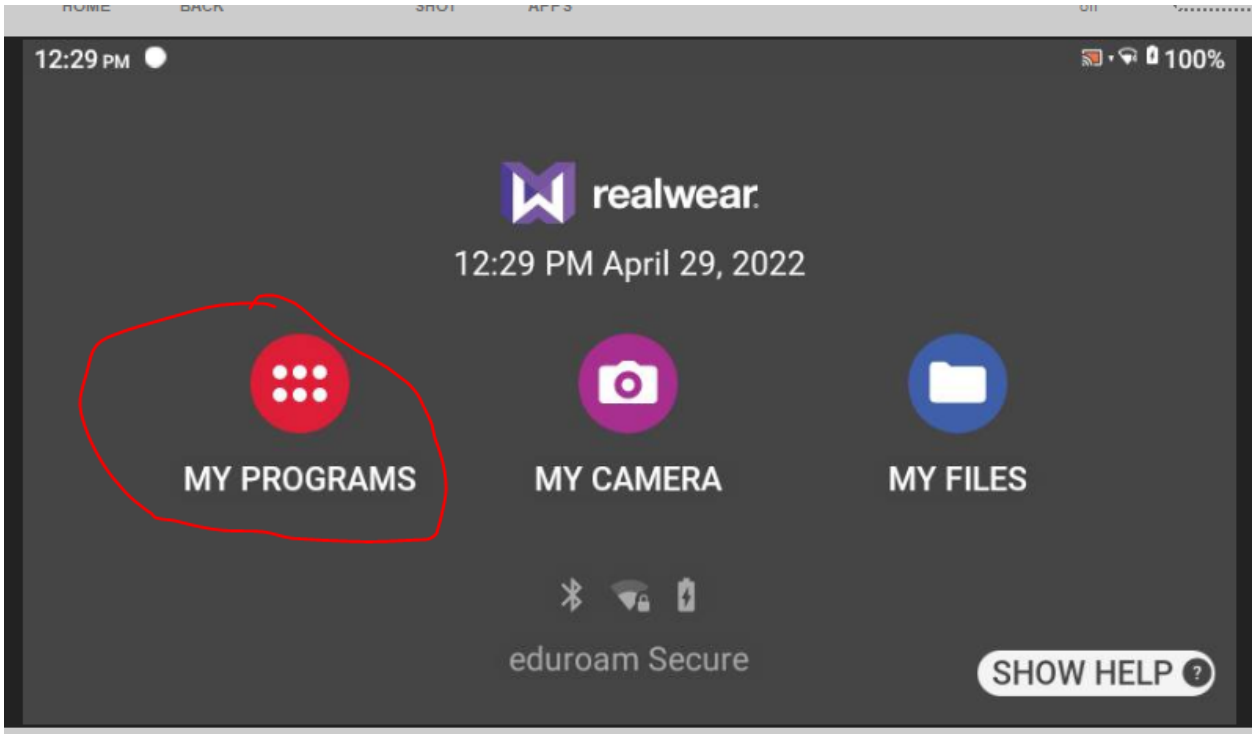
4. Important initial steps, device configuration

There are some important configuration steps that need to be taken before the HMT-1 can be fully utilized within any given scenario. This section outlines this necessary fine-tuning of the device, before its scenario usage.

4.1 - Set date & time to be automatically updated via the network.

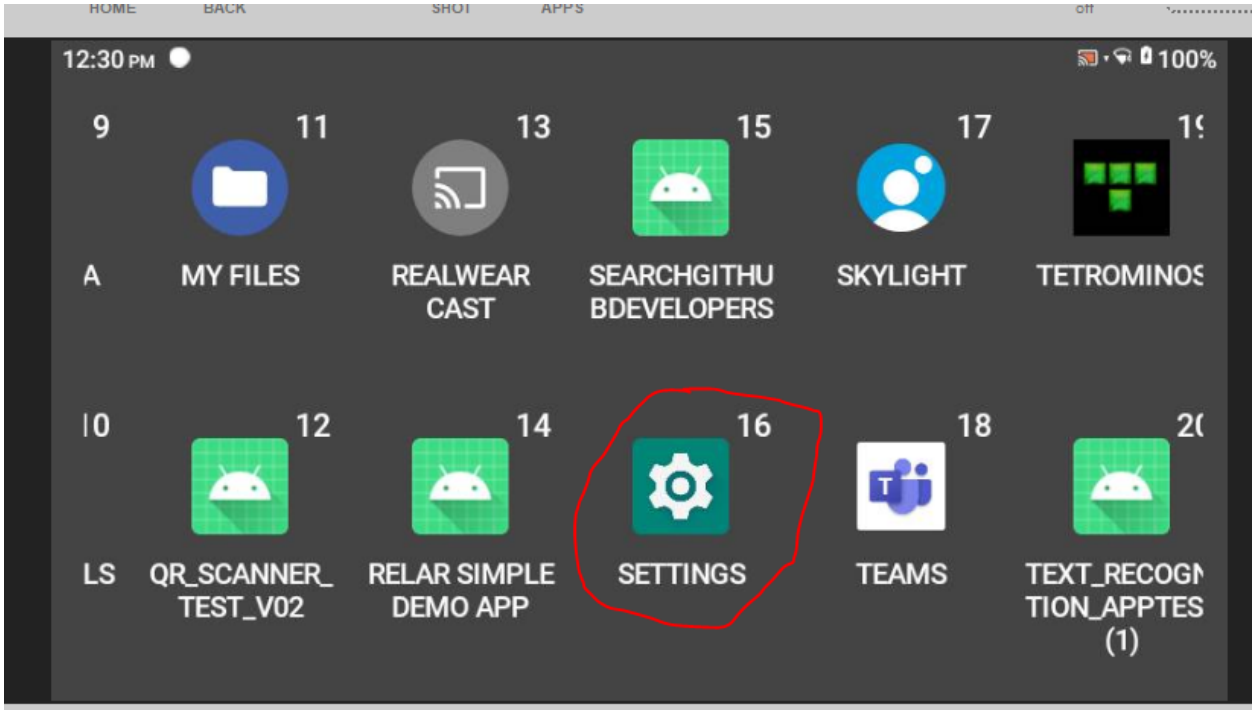
Accurate date & time is crucial for the proper functioning of some applications (even for successful login attempts), hence It's an important prerequisite to setup date and time to be automatically updated whenever the HMT-1 is connected to the internet. In order to do this, please perform the following:

From initial screen, choose **My Programs**



Step 1 - Choose MY PROGRAMS from the HMT-1 Home Screen

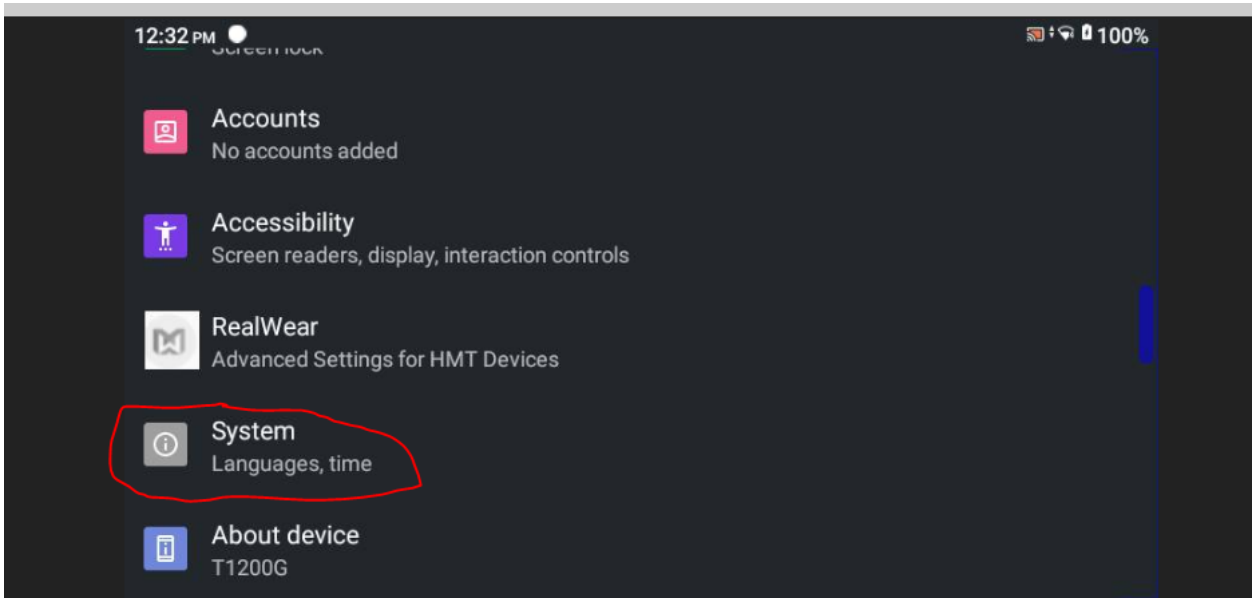
Choose **Settings**



Step 2 - Choose SETTINGS

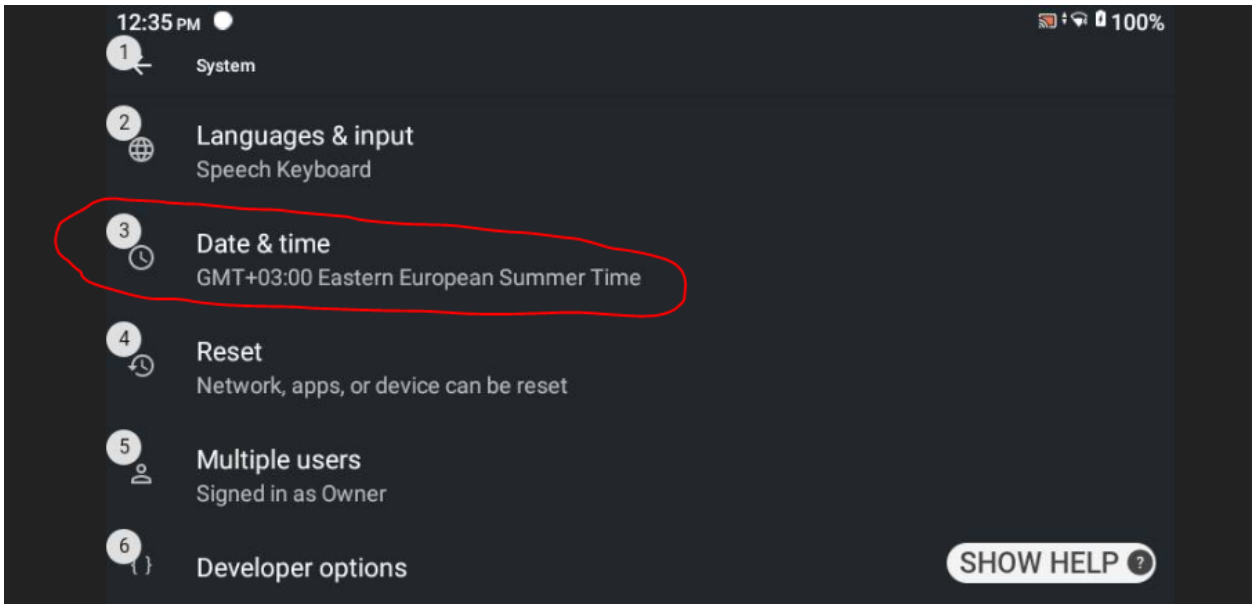
Browse to the bottom end of the list (either by vocal command **Page Down**, or by using the bottom arrow key if the HMT-1 is connected to a PC and controlled via RealWear Explorer).

Select `SYSTEM`.



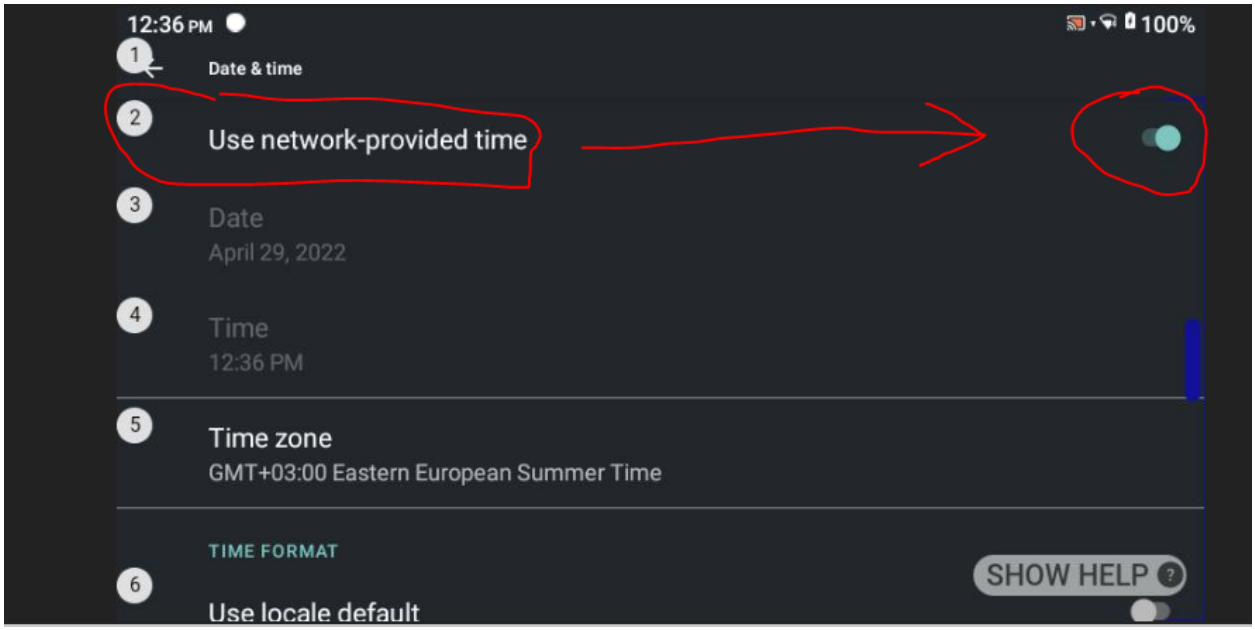
Step 3 - Select System

Choose `Date & Time`, either by vocal command `Date & Time`, or `Select Item 3`, or by clicking with the mouse, if using RealWear Explorer).



Step 4 - Select Date & Time

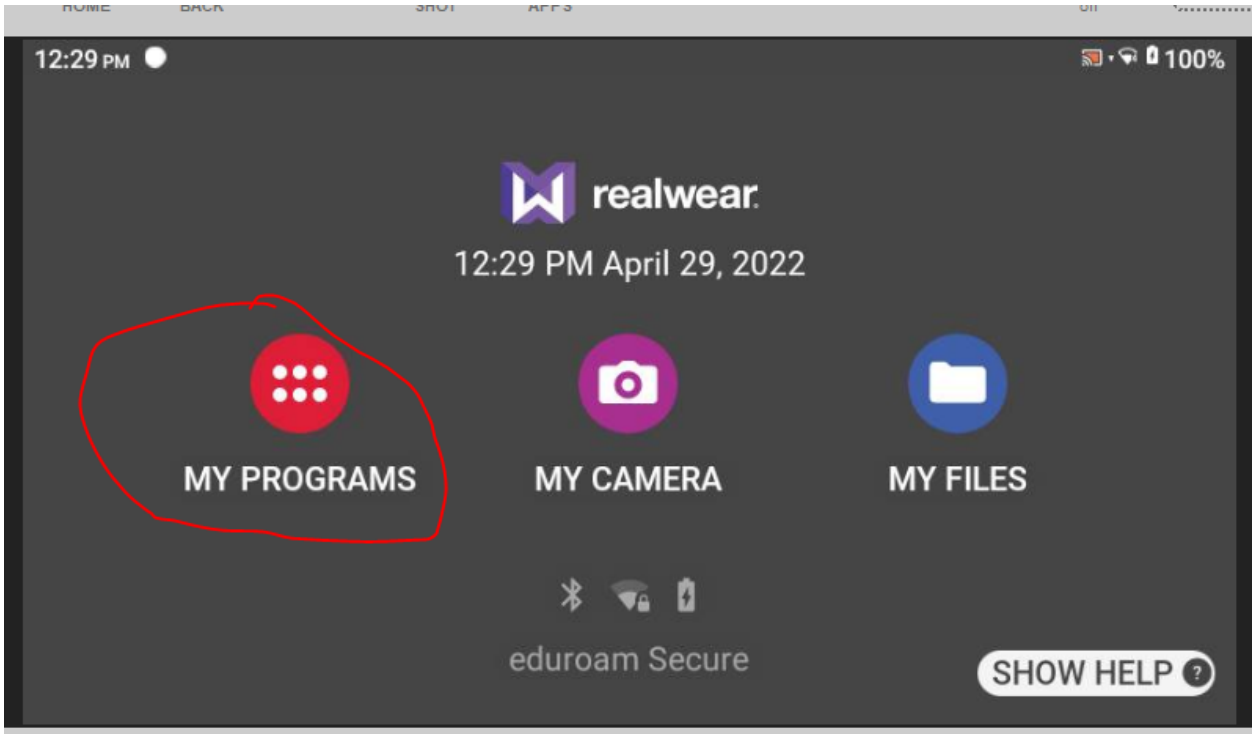
Make sure the toggle on item 2 is turned ON. You can either use the vocal command `Use network provided time`, or `select Item 2` to turn the toggle ON/OFF. Correct Time zone should be set automatically.



Step 5 (final) - Make sure 'Use network-provided time' toggle is turned ON

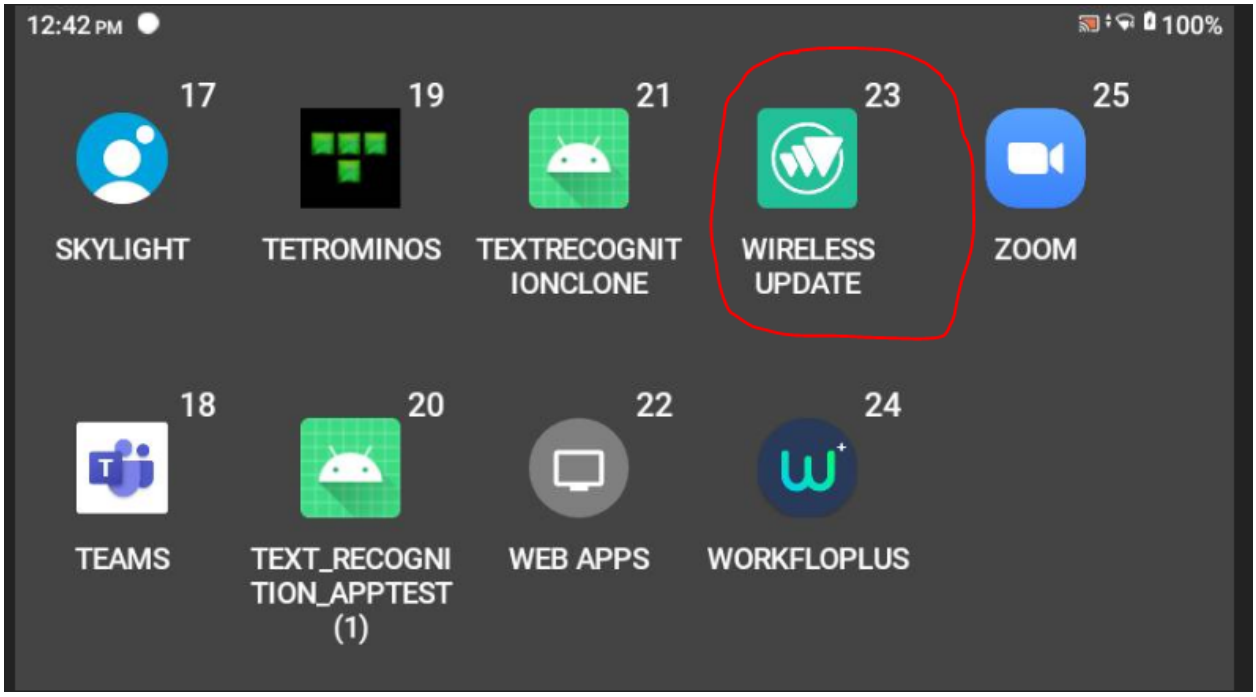
4.2 - Make sure the HMT-1 runs the latest firmware

There are frequent updates to the device's firmware. In order to have a common ground and to benefit from recent bug fixes and enhancements, we should make sure to run the latest operating system for the device. In order to do this, from the home screen select My Programs.



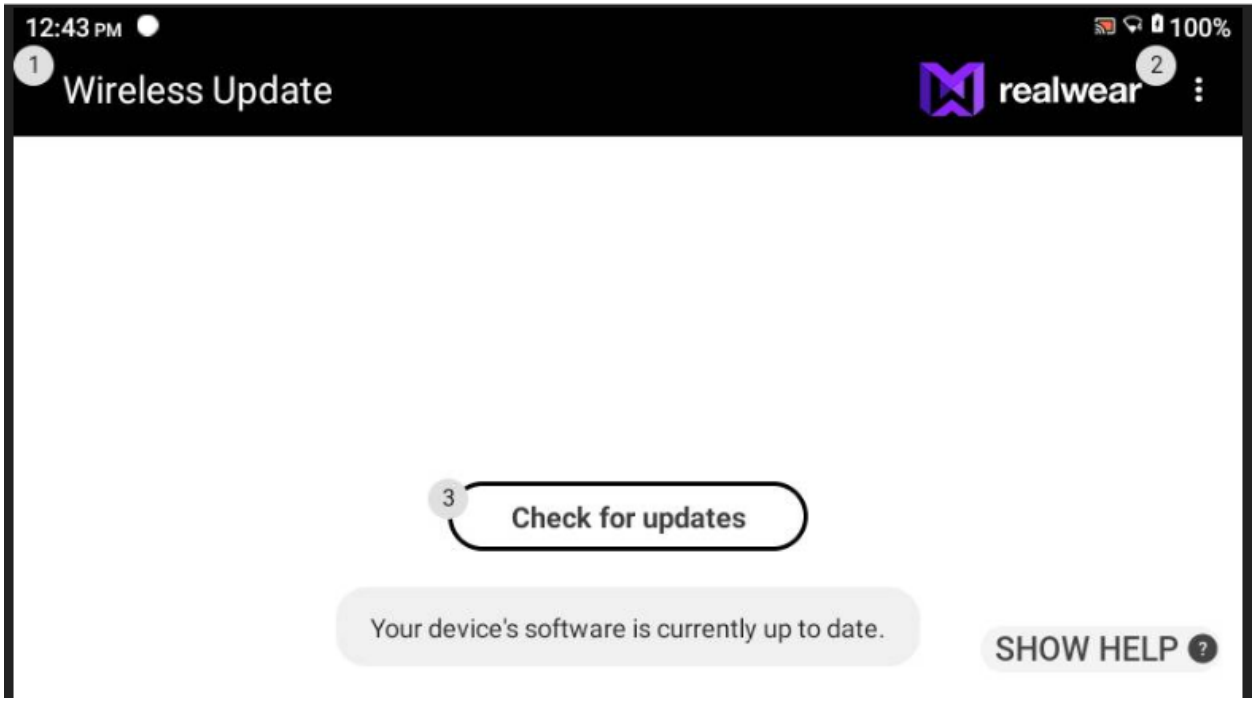
Step 1 - Select `MY PROGRAMS` *from the HMT-1 Home Screen*

Scroll all the way to the right, either by turning your head (if wearing the device) or using the right arrow key multiple times if using RealWear explorer. Select Wireless Update.



Step 2 - Select `WIRELESS UPDATE`

There will be an initial check, and If the device is currently running the latest firmware version, you should see this message:



Screenshot of device running latest firmware

Important notice:

If there are updates to install, you should see an appropriate message asking you to first download the next firmware version, and then install it.

The update is a straight-forward procedure that only takes a few minutes. Make sure to have a stable internet connection and either have sufficient battery charge (at least 30%) on the HMT-1 or have it connected and charging via USB.

Follow the screen messages to download and install the updates - bear in mind that the HMT-1 will reboot in the process so RealWear Explorer connection will be lost (but can resume after successful boot).

Also, note that updates are incremental - this means for example that if you have version 12.1 installed, and the current latest version is 12.3, you will need to perform the procedure twice, going from 12.1 to 12.2, and then from 12.2 to 12.3.

So after each update, you are advised to go through Wireless Update and check if you have the latest version installed.

5. Sharing files FROM the cloud TO the HMT-1.

5.1 - Introduction

There are several ways to share documents from an arbitrary endpoint (e.g. a desktop computer, laptop, mobile device, in essence any device that has internet connectivity) to the HMT-1. Most of them include either the use of a dedicated App (e.g. an email client) or sharing within the confines of an App that is already running (e.g. via MS Teams) or creating and using a dedicated QR code that "sends" the HMT-1 user to a URL where the file is available for download.

However, after testing various of the aforementioned methods, and after consulting with RealWear support, we conclude that at the time being, **the easiest and more flexible way of sharing different types of documents with the HMT-1 is by taking advantage of the recent built-in `CLOUD SYNC` app that should exist in all devices**[1] and allows for seamless connection and sync with Microsoft's OneDrive online cloud storage service.

5.2 - Pros and Cons

The major advantage, and essentially the deciding factor in suggesting `CLOUD SYNC`, is the fact that multiple different files can be shared easily and at once using this method, and the necessary app (`CLOUD SYNC`) is readily available as part of the device's standard software configuration (following OS version 11.2).

The disadvantage is that currently only Microsoft's OneDrive is supported and offline availability of files is not yet available (thus a cloud sync must be performed each time before accessing files on the HMT-1). However active development towards solving these issues is currently being performed at RealWear so there is good reason to utilize `CLOUD SYNC` and benefit from future enhancements[2].

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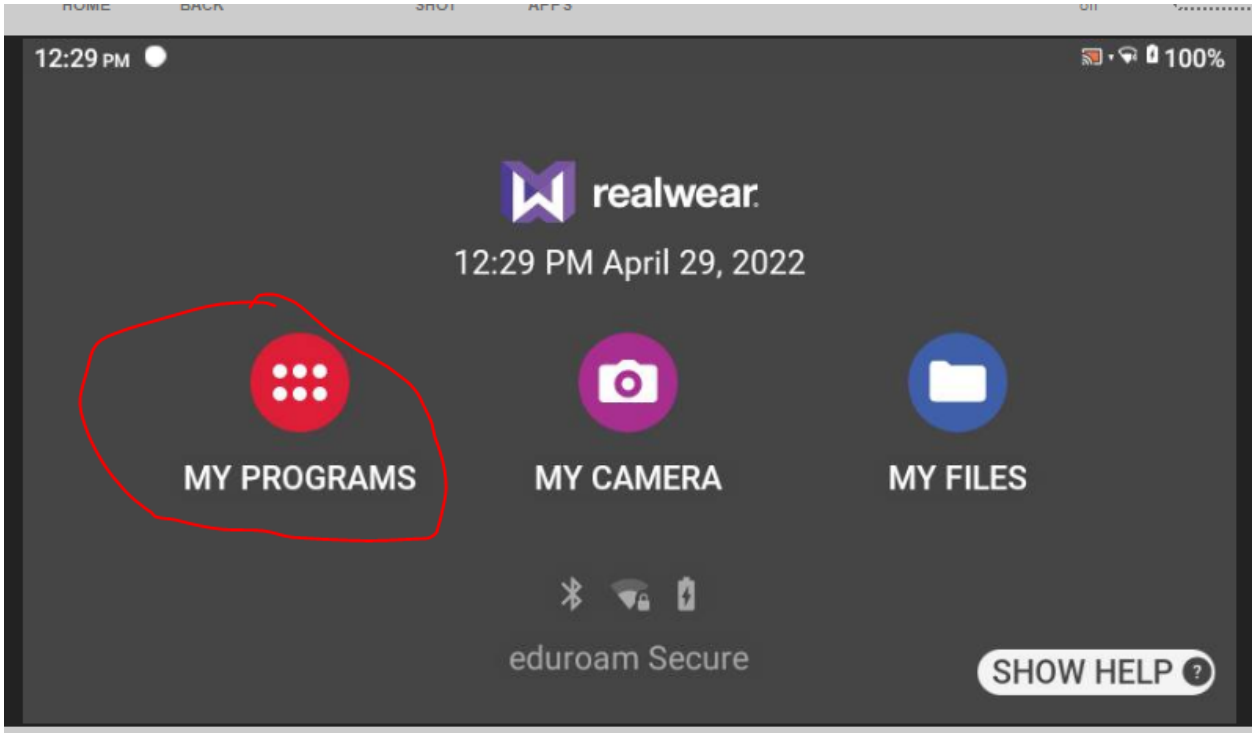
[1] `CLOUD SYNC` is included on HMT-1 starting with Release 11.2. At the time of writing (April 2022), HMT-1 runs release version 12.3.

[2] More specifically, from the official RealWear website: "Currently it is only possible to browse OneDrive files while connected to the internet. These are not yet synced and available offline. We are evaluating features such as download and the ability to support other cloud storage drives like Dropbox, Box and Google Drive as part of our device software roadmap". See https://support.realwear.com/knowledge/cloud-sync for more information.

5.3 - Setting up CLOUD SYNC for the first time (needed only once, for a particular account)

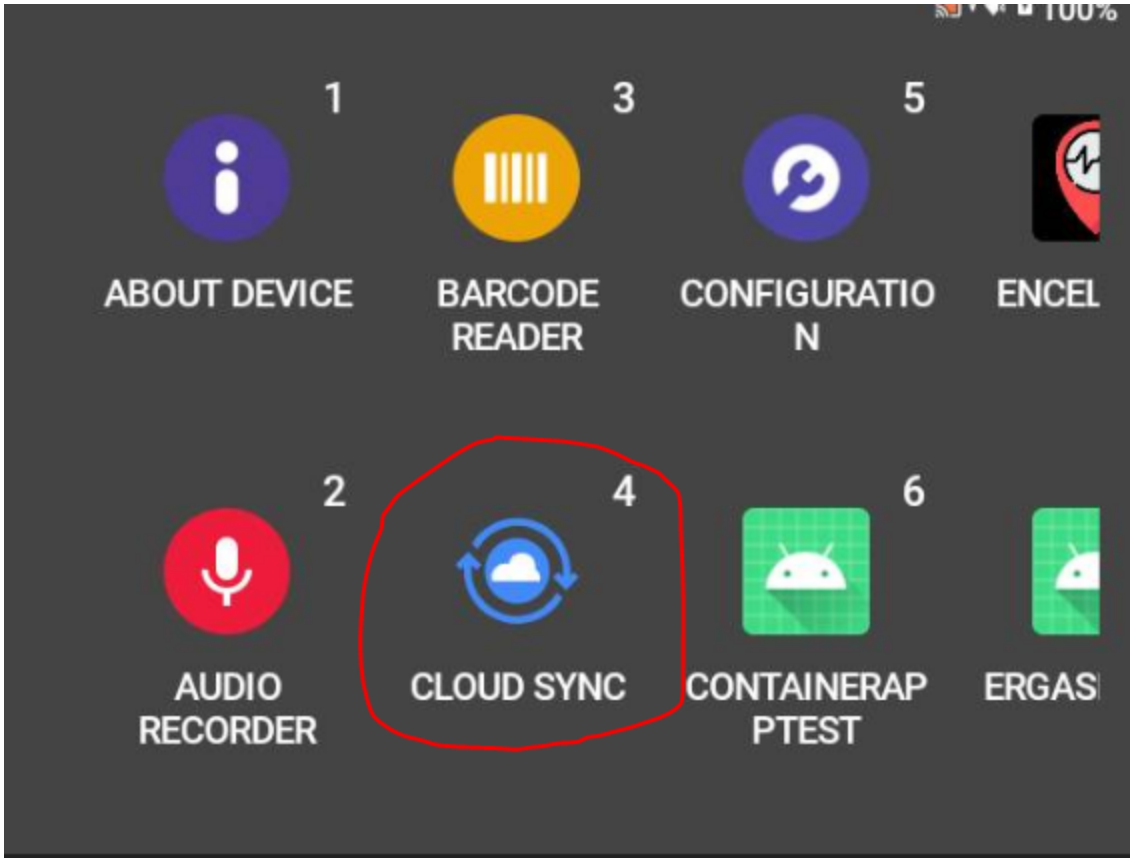
The first time we use the `CLOUD SYNC` app on the HMT-1, we need to connect it to an account in OneDrive. Once this connection is established, `CLOUD SYNC` will be automatically linked to that account unless we decide to sign off. Following are the steps needed for the one-off connection:

From the `HOME SCREEN`, select `MY PROGRAMS`:



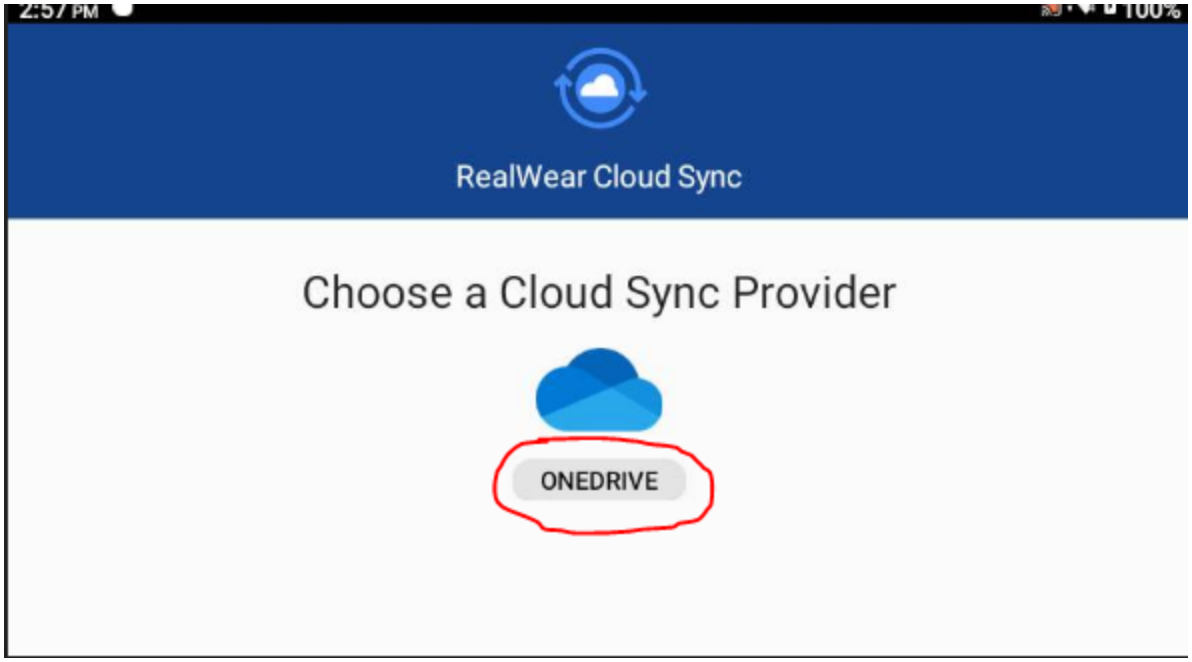
Step 1 - Select MY PROGRAMS from the HMT-1 Home Screen

Scroll to the left and choose `CLOUD SYNC`:



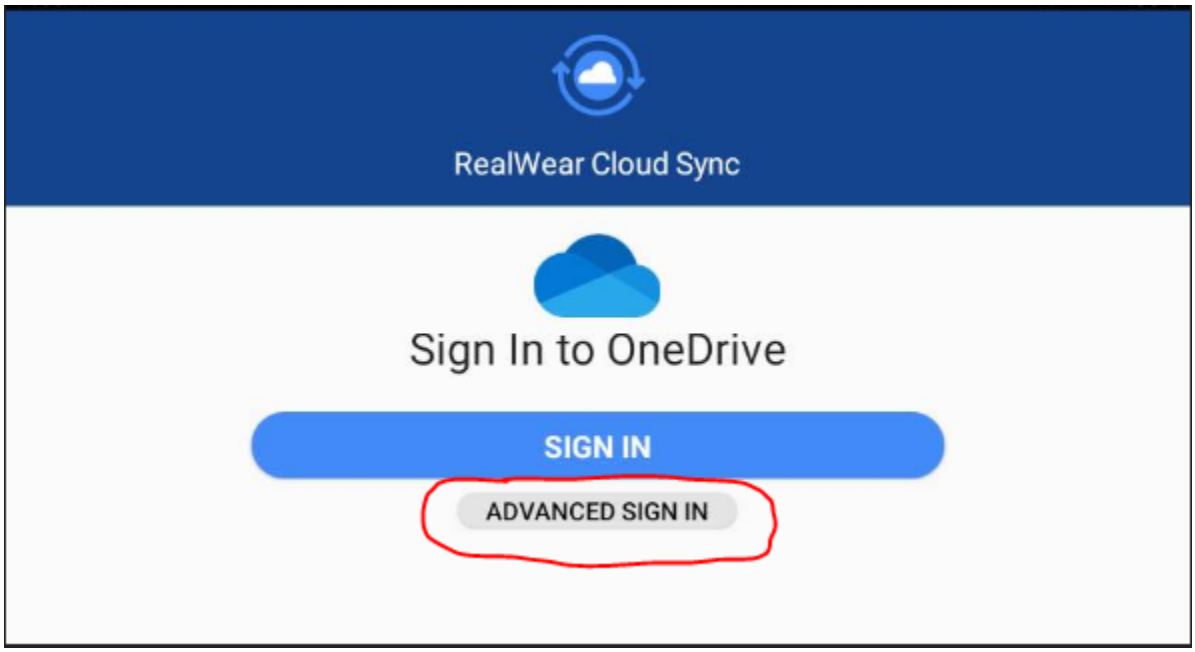
Step 2 - Select CLOUD SYNC

Select `ONEDRIVE`



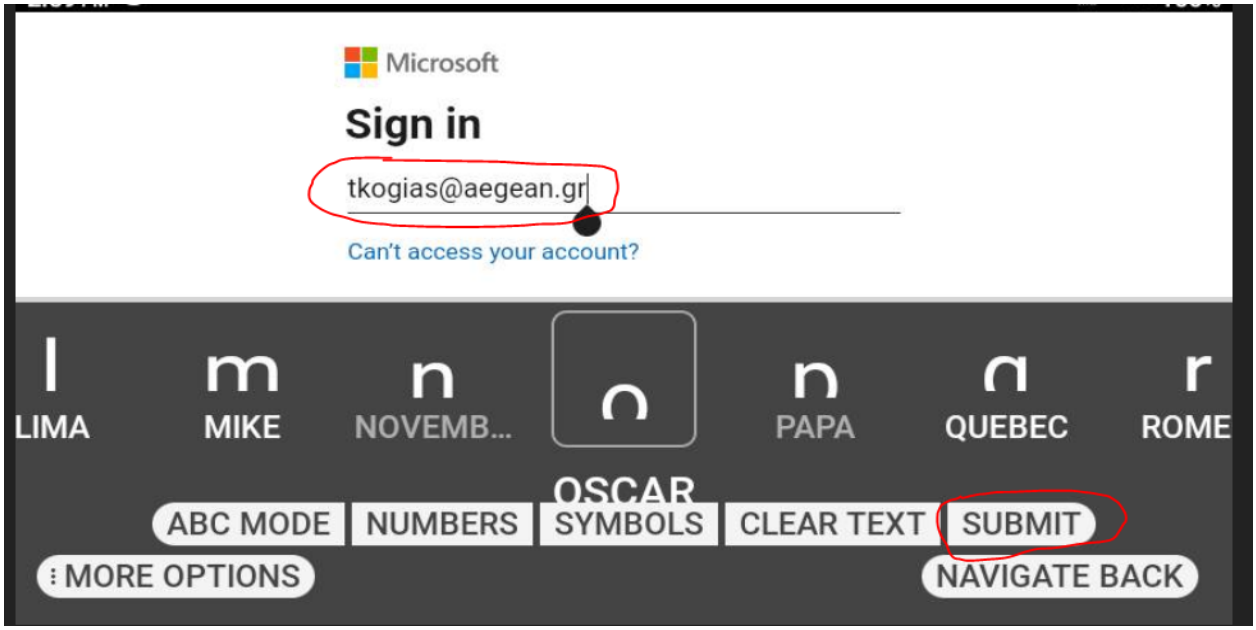
Step 3 - Select ONEDRIVE

Select `ADVANCED SIGN IN`



Step 4 - Select ADVANCED SIGN IN

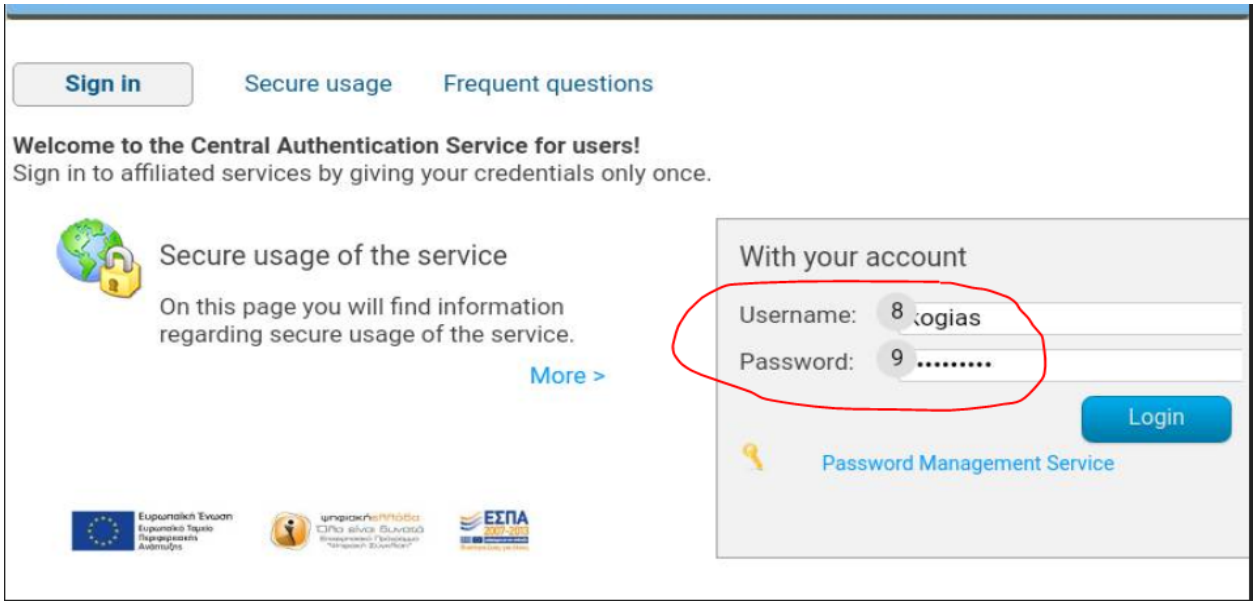
Enter the email of the OneDrive account:



Step 5 - Enter the full login for your microsoft account

Select `SUBMIT` or `NEXT` (depending on what screen you see).

Depending on your account, you might be asked to provide credentials on a dedicated page, probably belonging to your organization. This is the case in our example, since the OneDrive account used belongs to a member of the University of the Aegean. The user is transferred to the organization's Central Authentication Service to provide credentials.



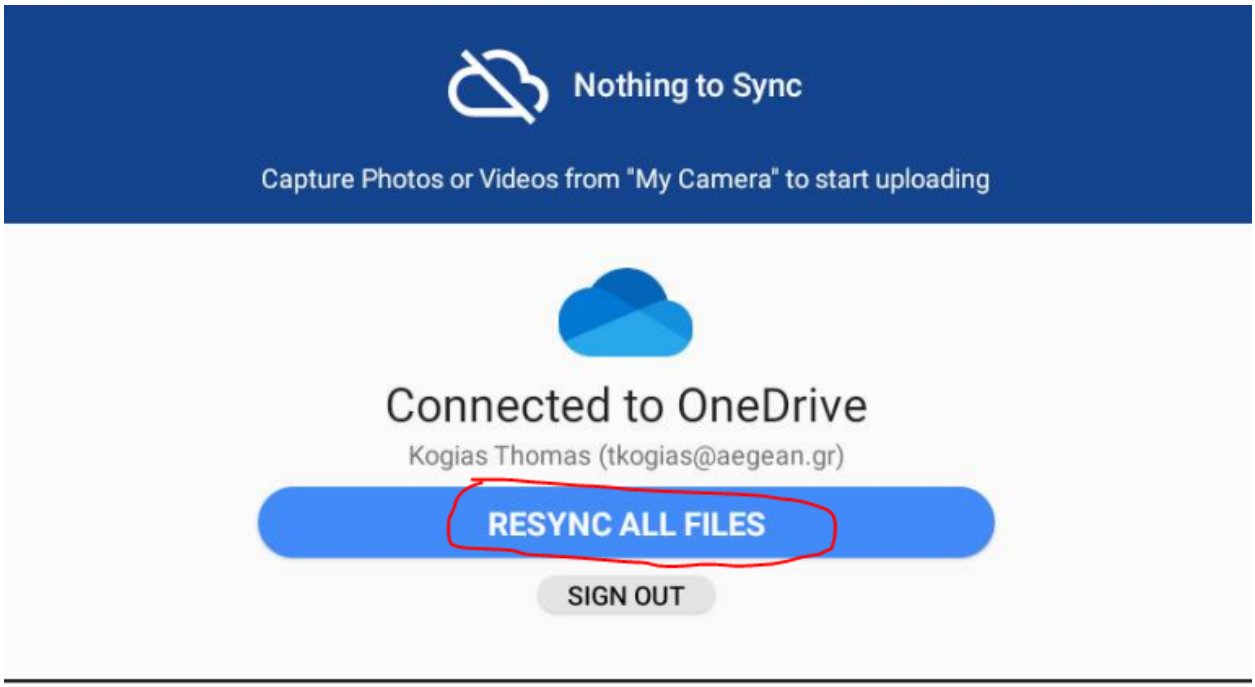
Step 6 (optional) - Use your organization's central authentication service

***Note**: It could be easier to provide such information using RealWear explorer as one can readily type characters in a computer keyboard.*

5.4 - Sharing files from OneDrive to HMT-1

Once a successful login is made, from now on `CLOUD SYNC` on the HMT-1 is connected to that account and can readily share documents back and forth.

Select `RESYNC ALL FILES`

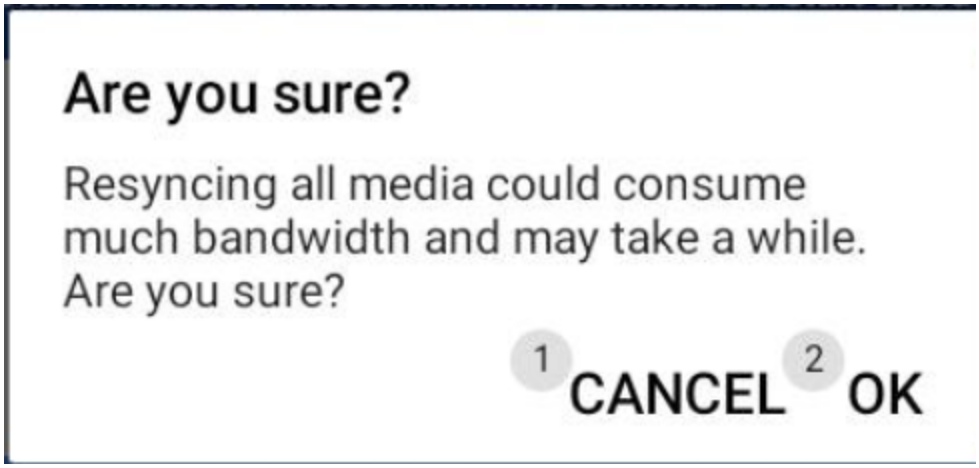


Step 7 - Select RESYNC ALL FILES

Selecting `RESYNC ALL FILES` will download all files from that account onto the HMT-1 and vice versa (uploading photos/videos taken with the HMT-1).

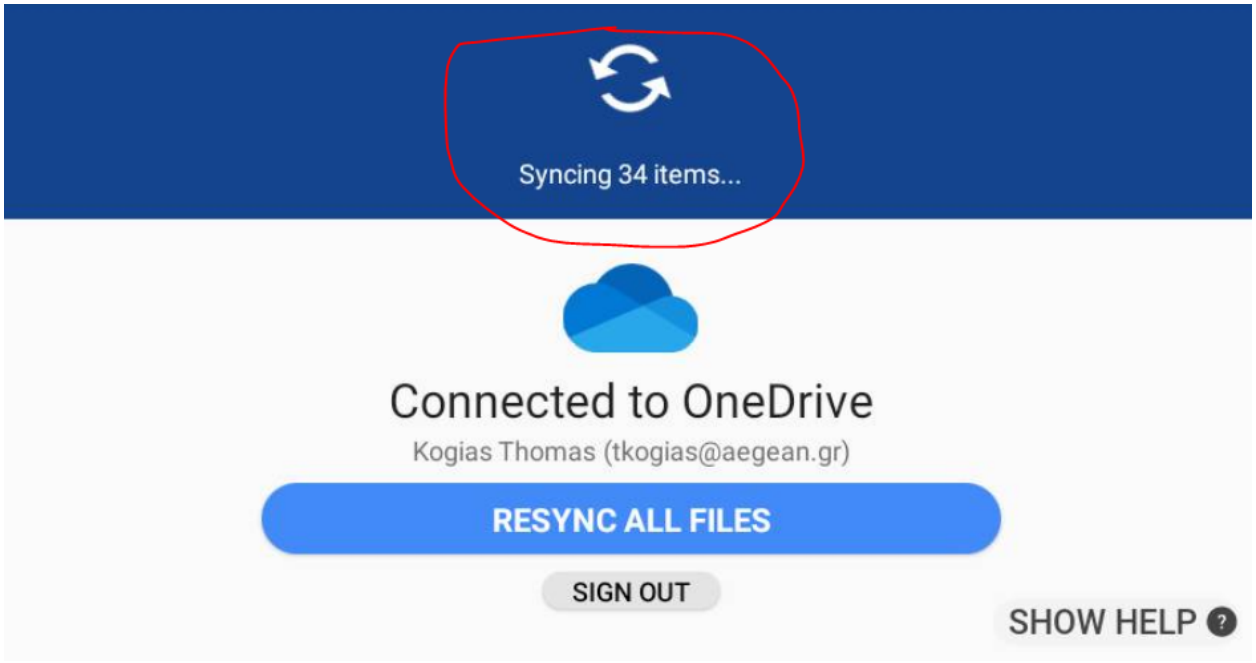
Please bear in mind that depending on the total size of files shared within OneDrive, this procedure might take too long and/or fill up HMT-1 storage with unnecessary files. **You are strongly advised to either use an account specifically designated for the HMT-1 or one that simply does not have too many files stored.**

Once `RESYNC ALL FILES` is clicked, you are asked for confirmation:



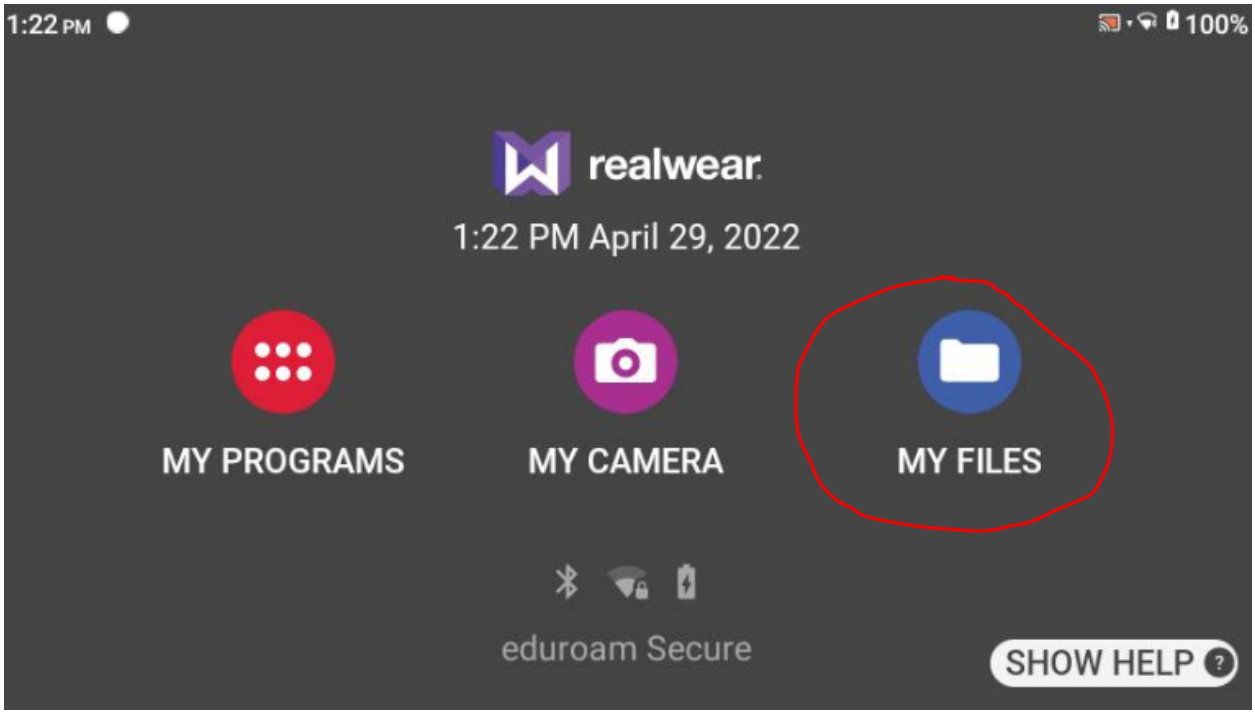
Step 8 - Select OK

Click `OK` and transfer of files will begin:



Step 9 - Syncing files

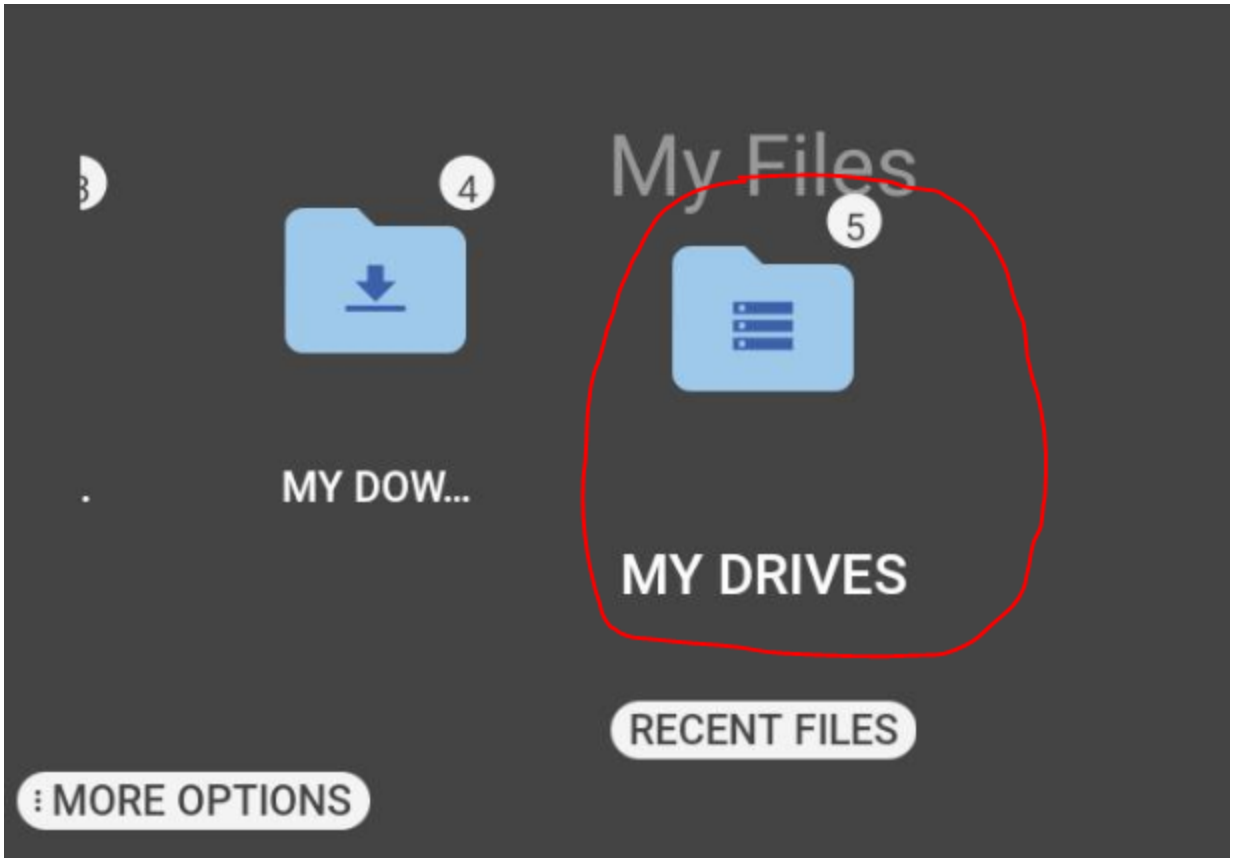
Once transfer is complete, you can return to the HMT-1 `HOME` screen and click on `MY FILES`.



Step 10 - Select MY FILES from the HMT-1 HOME screen

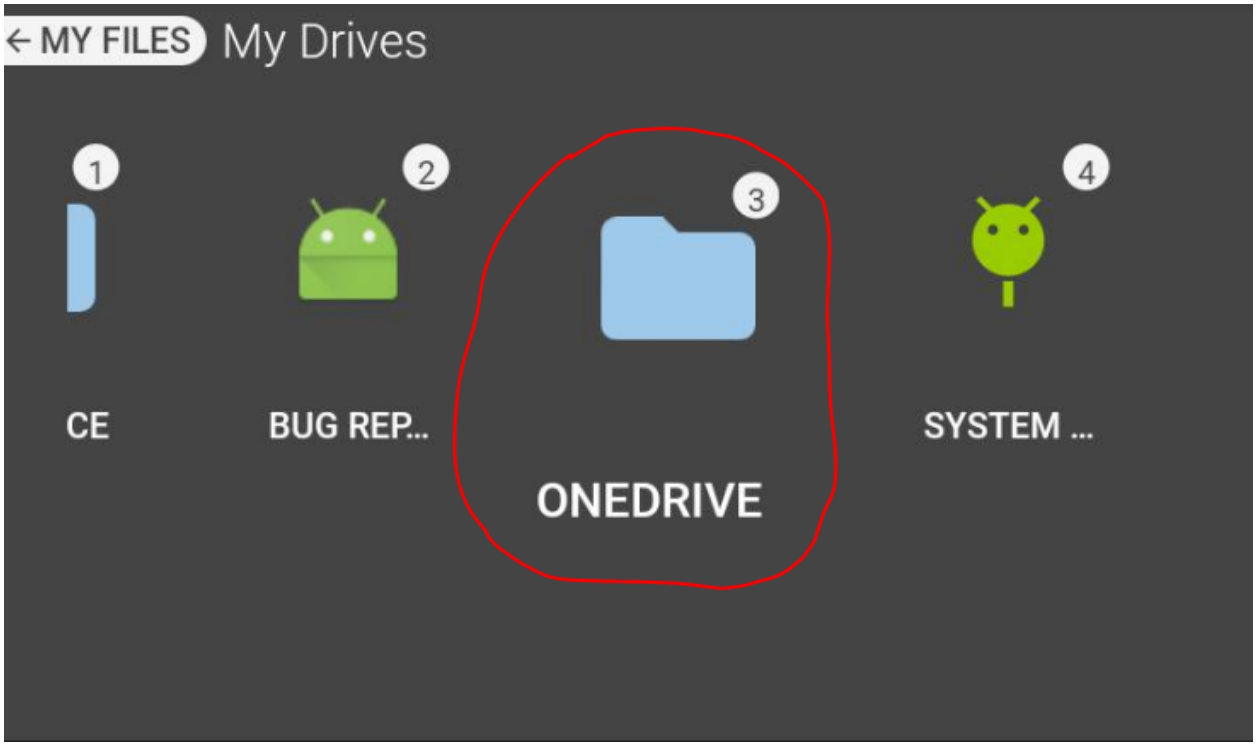
Now you will be browsing the files in HMT-1. Depending on whether you have opened up ‘MY FILES’ before, you will be either in the root folder, or whatever folder you have browsed before. Let’s suppose you start on the root folder.

Scroll to the right and choose the folder `MY DRIVES`**.**



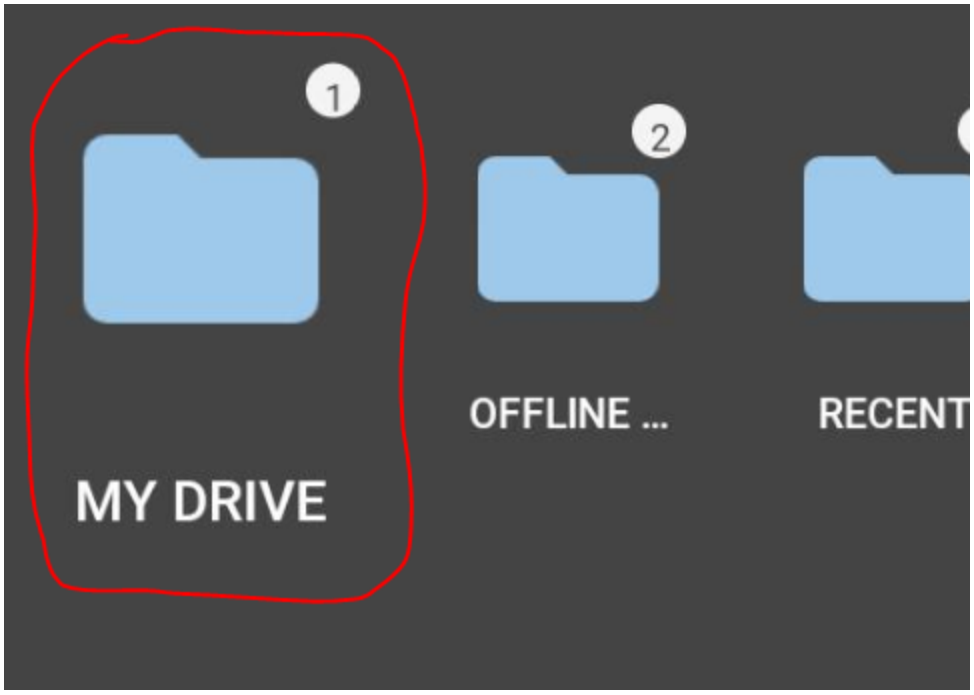
Step 11 - Select MY DRIVES

Select `ONEDRIVE`



Step 12 - Select ONEDRIVE

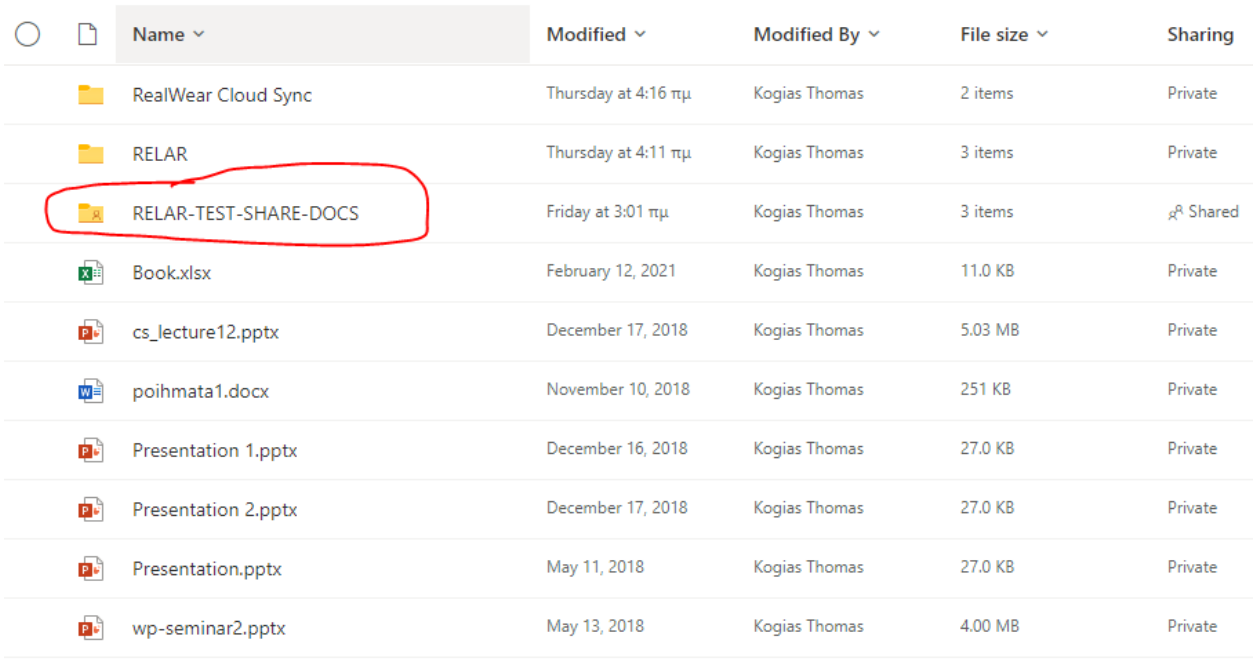
Select `MY DRIVE`



Step 13 - Select MY DRIVE

You should now be browsing the OneDrive root folder.

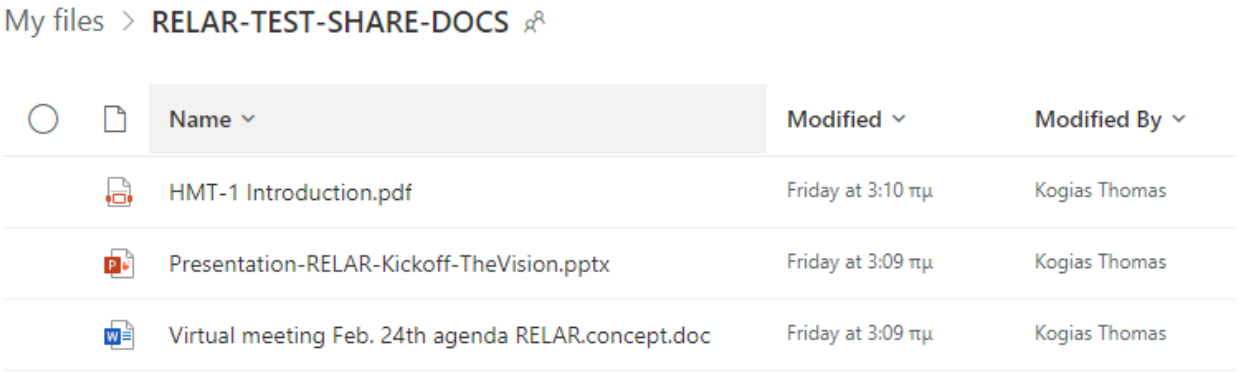
In the example OneDrive account used for this technical paper, a folder named RELAR-TEST-SHARE-DOCS has been created, containing PDF, PPTX and DOCX files. Here is the folder seen from a PC web browser:



Name	Modified	Modified By	File size	Sharing
RealWear Cloud Sync	Thursday at 4:16 πμ	Kogias Thomas	2 items	Private
RELAR	Thursday at 4:11 πμ	Kogias Thomas	3 items	Private
RELAR-TEST-SHARE-DOCS	Friday at 3:01 πμ	Kogias Thomas	3 items	Shared
Book.xlsx	February 12, 2021	Kogias Thomas	11.0 KB	Private
cs_lecture12.pptx	December 17, 2018	Kogias Thomas	5.03 MB	Private
poihmata1.docx	November 10, 2018	Kogias Thomas	251 KB	Private
Presentation 1.pptx	December 16, 2018	Kogias Thomas	27.0 KB	Private
Presentation 2.pptx	December 17, 2018	Kogias Thomas	27.0 KB	Private
Presentation.pptx	May 11, 2018	Kogias Thomas	27.0 KB	Private
wp-seminar2.pptx	May 13, 2018	Kogias Thomas	4.00 MB	Private

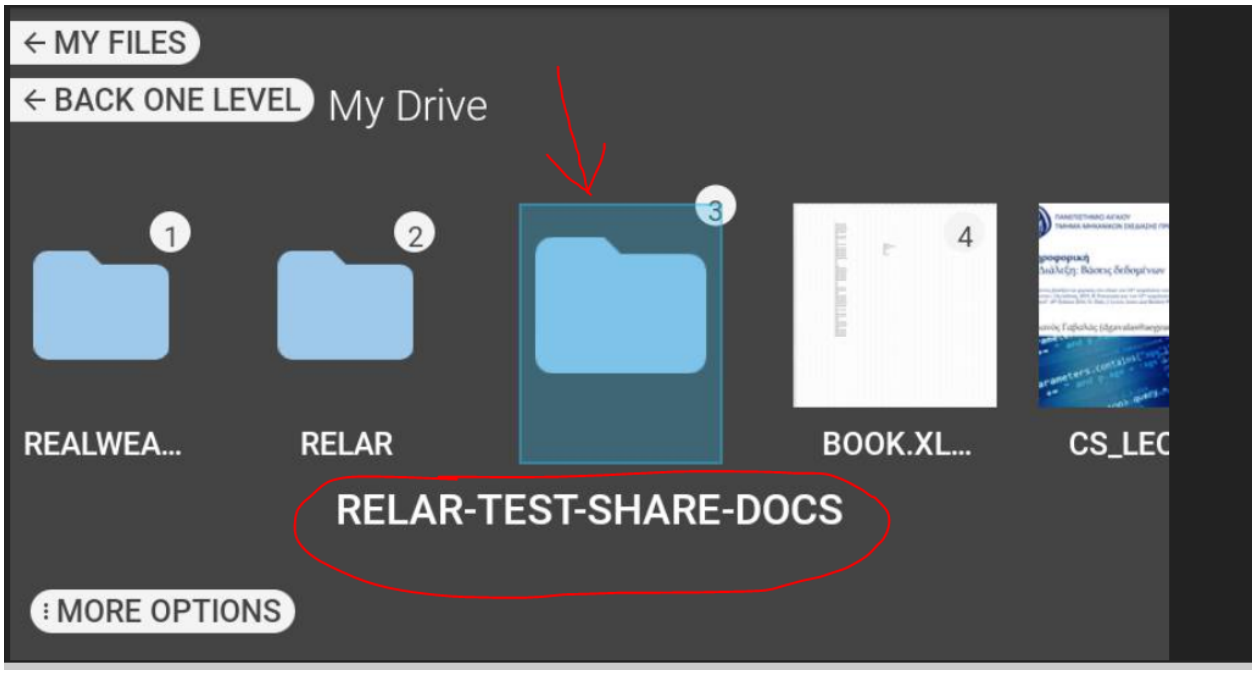
RELAR-TEST-SHARE-DOCS OneDrive folder, seen from a computer web interface

Within this example folder:



Contents of RELAR-TEST-SHARE-DOCS folder

Back onto the HMT-1, the user selects the same folder (in this example, easiest method of selection is by voice command, `SELECT ITEM 3` - or by clicking appropriately if using the RealWear explorer.



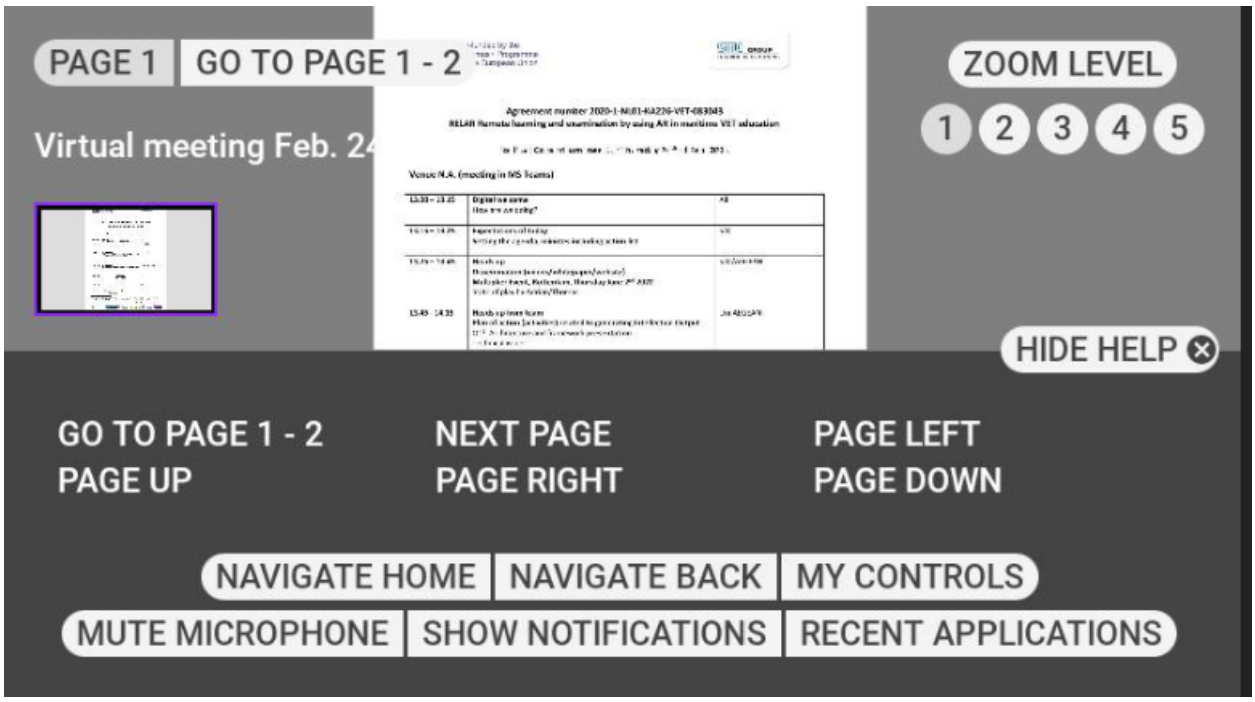
Select appropriate folder

Selecting the particular folder will open up its contents - in this particular example, we see the files (DOC, PDF, PPTX) readily available for browsing through the HMT-1.

Folder contents seen from the HMT-1 User Interface

Using the vocal command "`select item #`', the user can open up each document.

Following is a screenshot of HMT-1 browsing a DOC document, with the option SHOW HELP turned on:



Viewing a DOC file through the HMT-1

Users can issue vocal commands to browse through the document and apply different zoom levels.

Viewing a PPTX presentation through the HMT-1, with zoom level 2 applied

Users can similarly browse all different files - successful tests have been made with PDF, DOC, PPT files.

5.5 - Sharing files from an arbitrary Gmail user to the HMT-1.

In the previous section, sharing files from a **specific** OneDrive account to the HMT-1 was demonstrated. However, it is possible to leverage the use of OneDrive **in order to share files from an arbitrary endpoint to the HMT-1**.

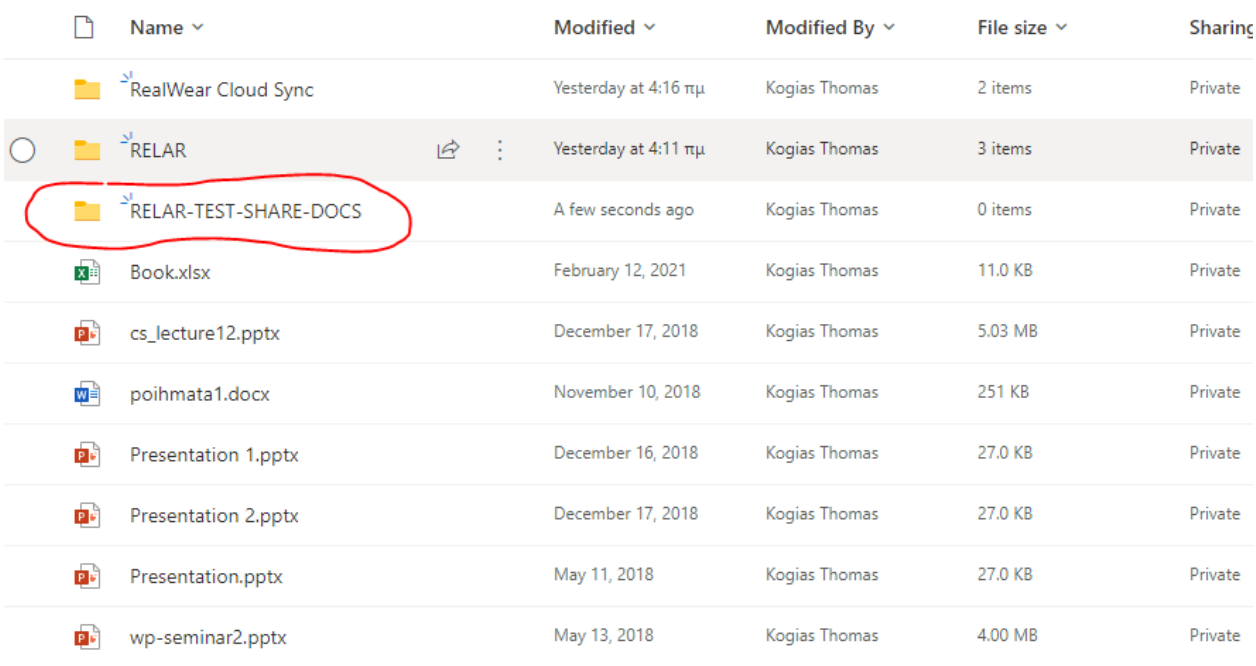
In the following section, the use of an arbitrary Gmail account will be demonstrated:

The basic necessary step is to share a particular folder from the OneDrive User Interface, and give editor rights to an arbitrary Gmail user (in this example, tkogias@gmail.com).

Then that particular Gmail user will be notified via email, and will be given a link to upload files onto the designated folder. Once this is done, those files will be accessible on the HMT-1 after a successful `RESYNC ALL FILES` through the `CLOUD SYNC` app.

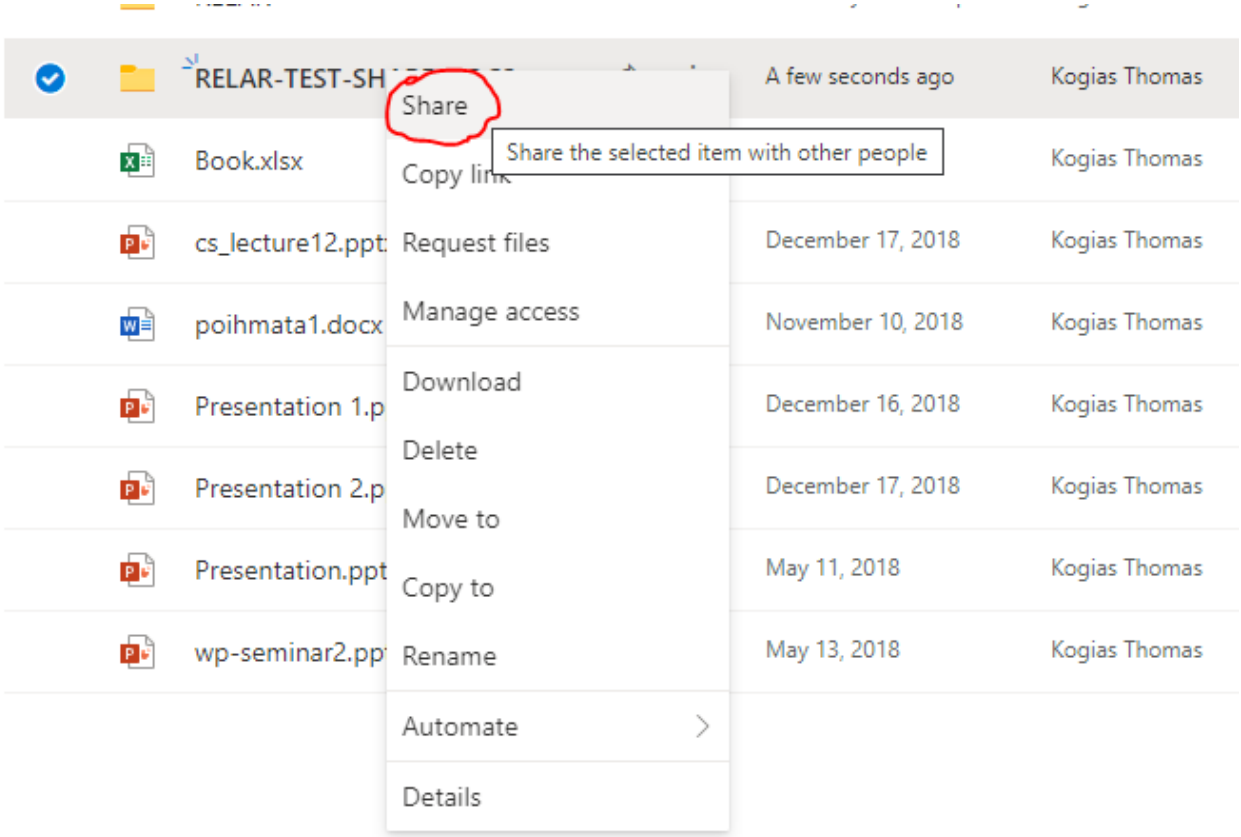
The procedure is highlighted below:

Right click folder within OneDrive, in order to give permissions to an arbitrary Gmail user:



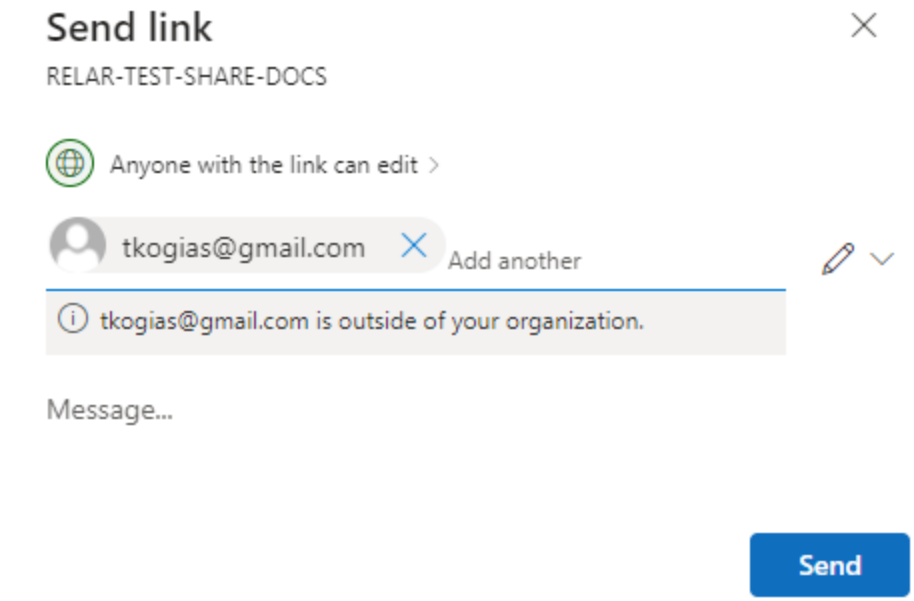
Right-click folder within OneDrive

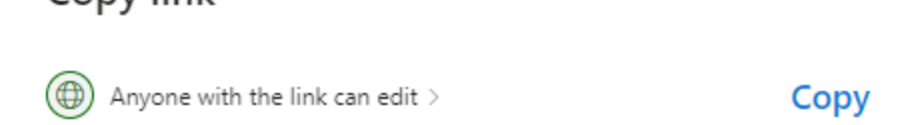
Choose 'Share'



Select `Share` option

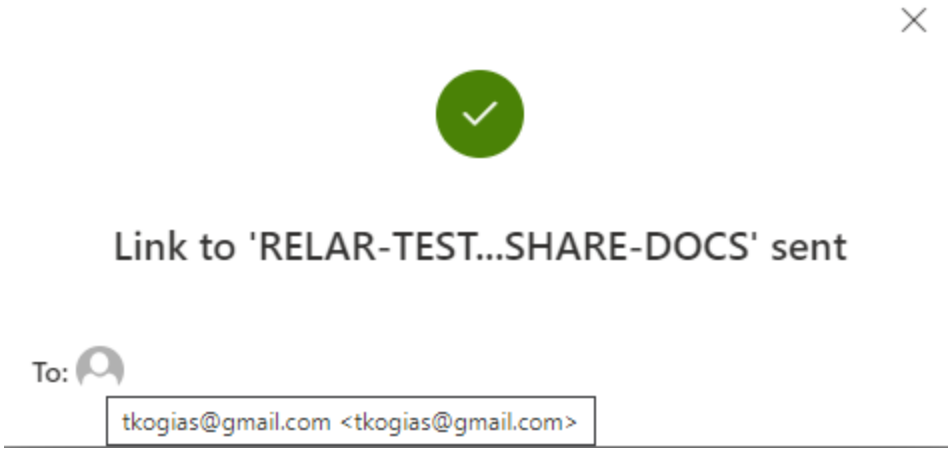
Enter the email of the person you intend to share the folder with (here a personal Gmail account - tkogias@gmail.com is used as an example). Once the recipient's email is entered, click *`Send`*.





Enter recipient account email, click `Send`.

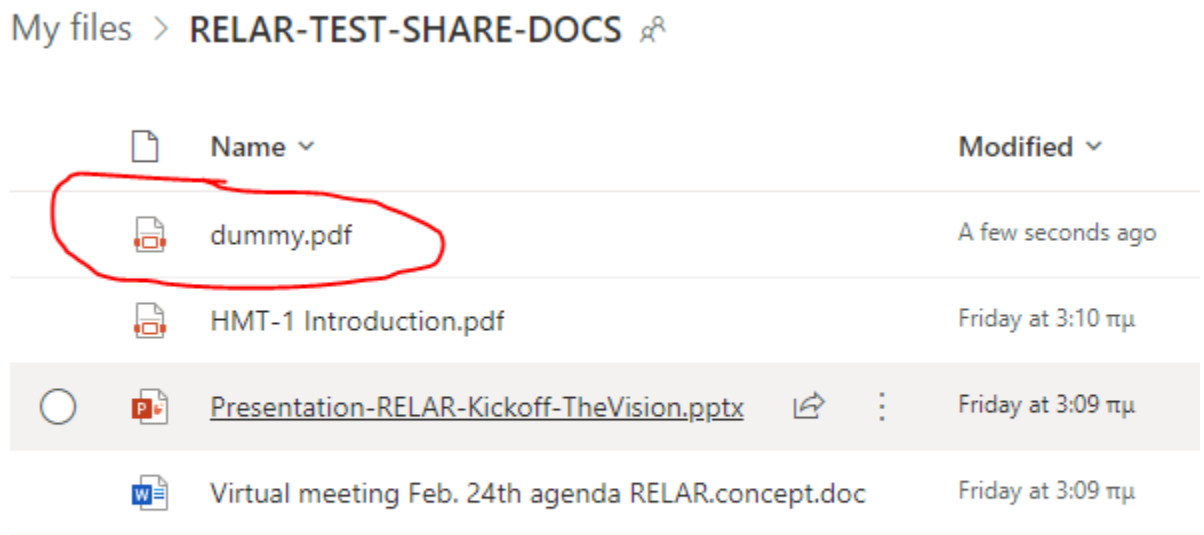
Once Send button is clicked, the invitation is confirmed:



Invitation sent and confirmed.

Now the recipient of the email can click on the link and be presented with a web User Interface for OneDrive, where documents can be uploaded.

As a test, a new PDF file is uploaded (filename: dummy.pdf).

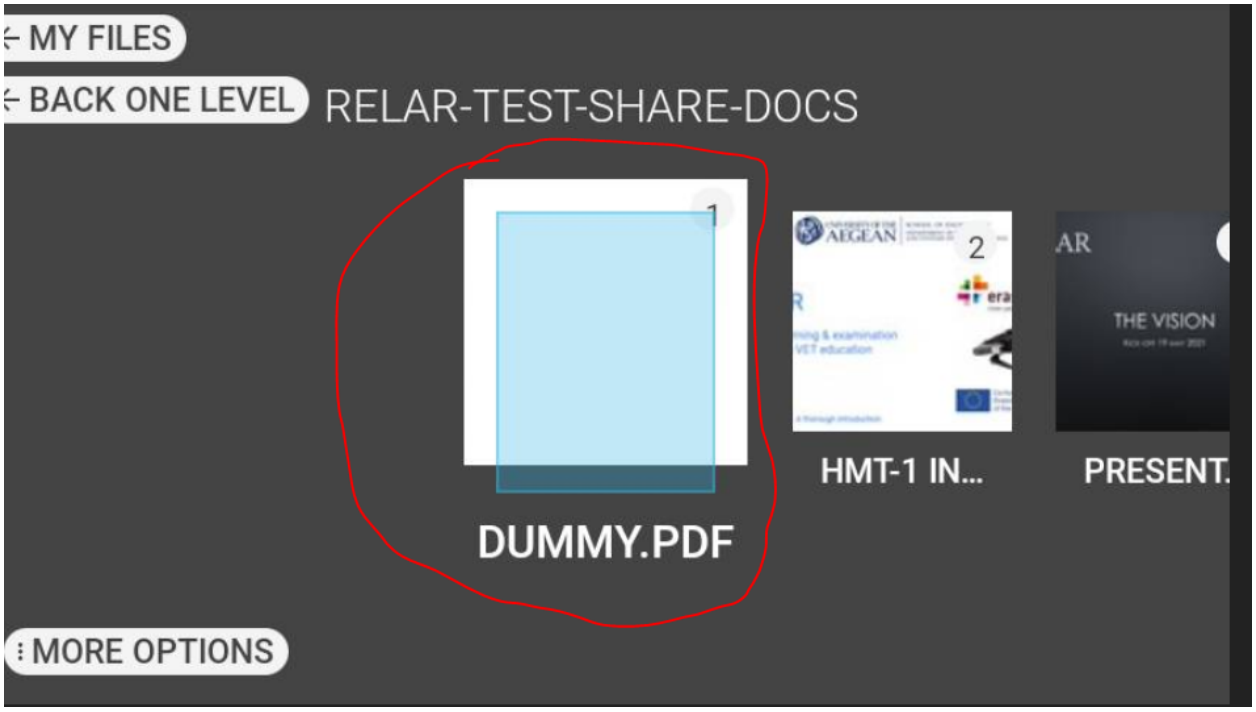


A new PDF file (dummy.pdf) is uploaded to the shared OneDrive folder.

In order to access the newly uploaded file, the HMT-1 user must do the following:

Select `HOME SCREEN` -> `CLOUD SYNC` -> `RESYNC ALL FILES`

Then select `MY FILES` and open the right folder, where the recently uploaded file (by an arbitrary Gmail user) is there to be browsed within the HMT-1:



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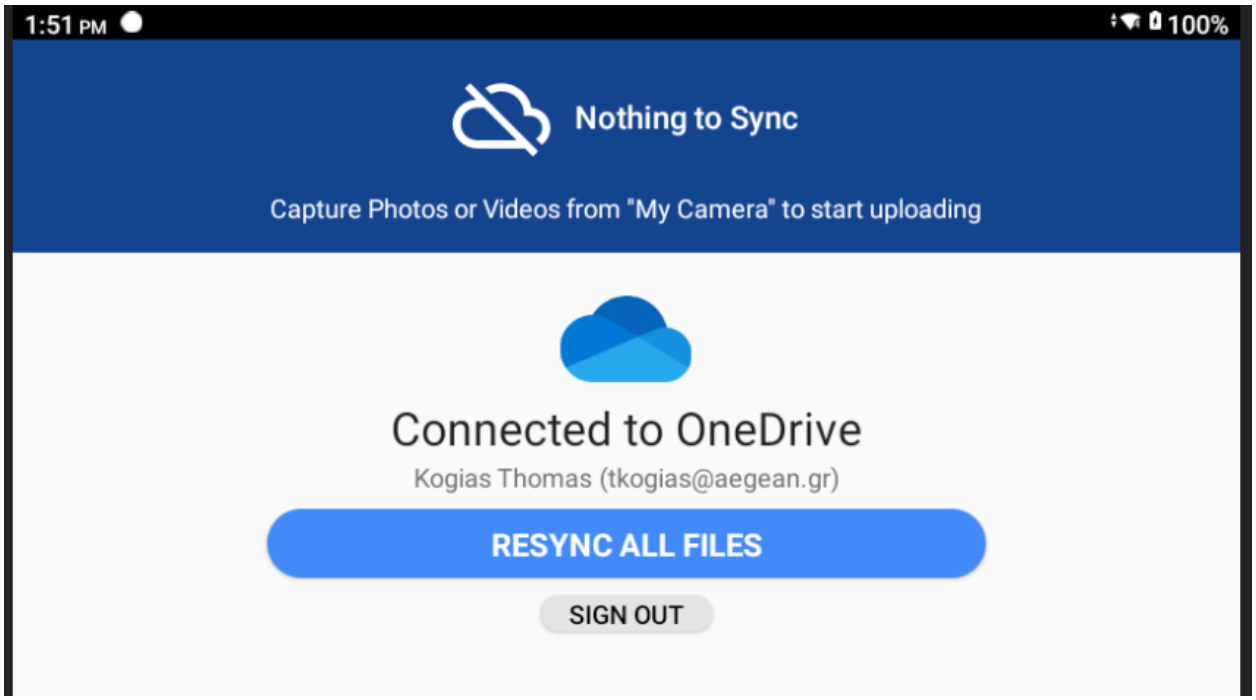
6. Sharing files (images and videos) from HMT-1 to an arbitrary endpoint

In order to share files created by the HMT-1 user (images and videos captured with the device), the preferred way is again by **taking advantage of the recent built-in `CLOUD SYNC` app that should exist in all devices**.

The procedure is documented below, from the ground up:

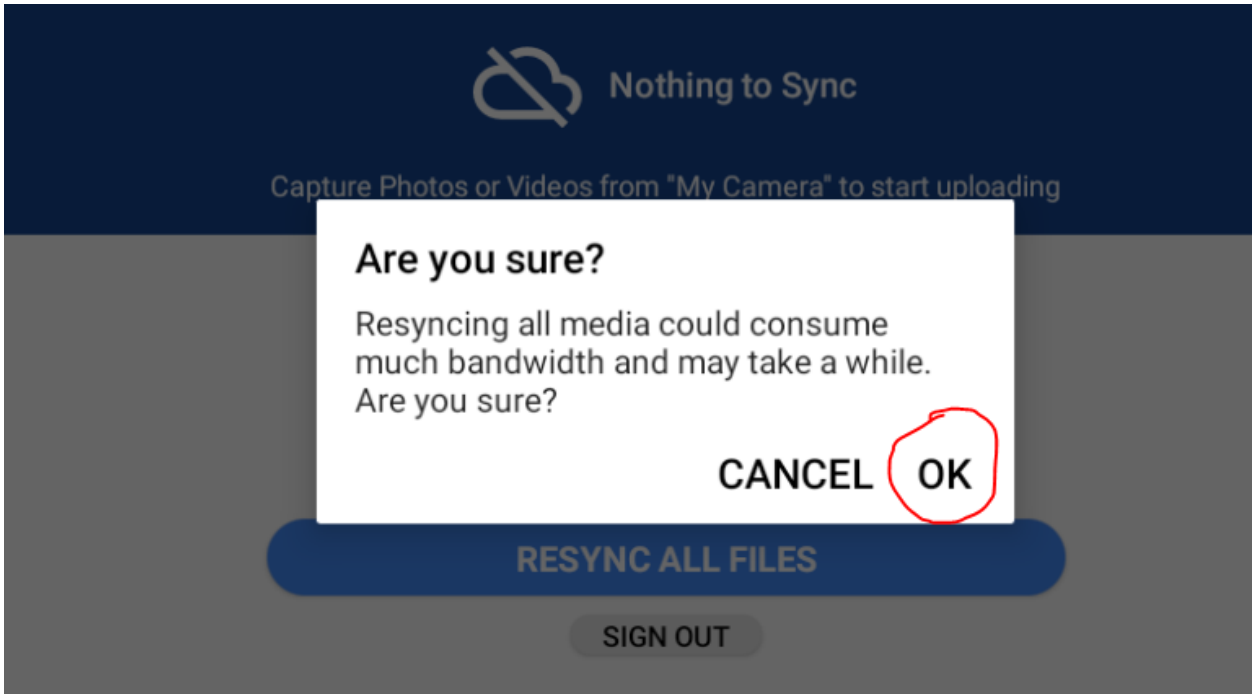
Select `HOME SCREEN` -> `MY PROGRAMS` -> `CLOUD SYNC`.



CLOUD SYNC app's first page

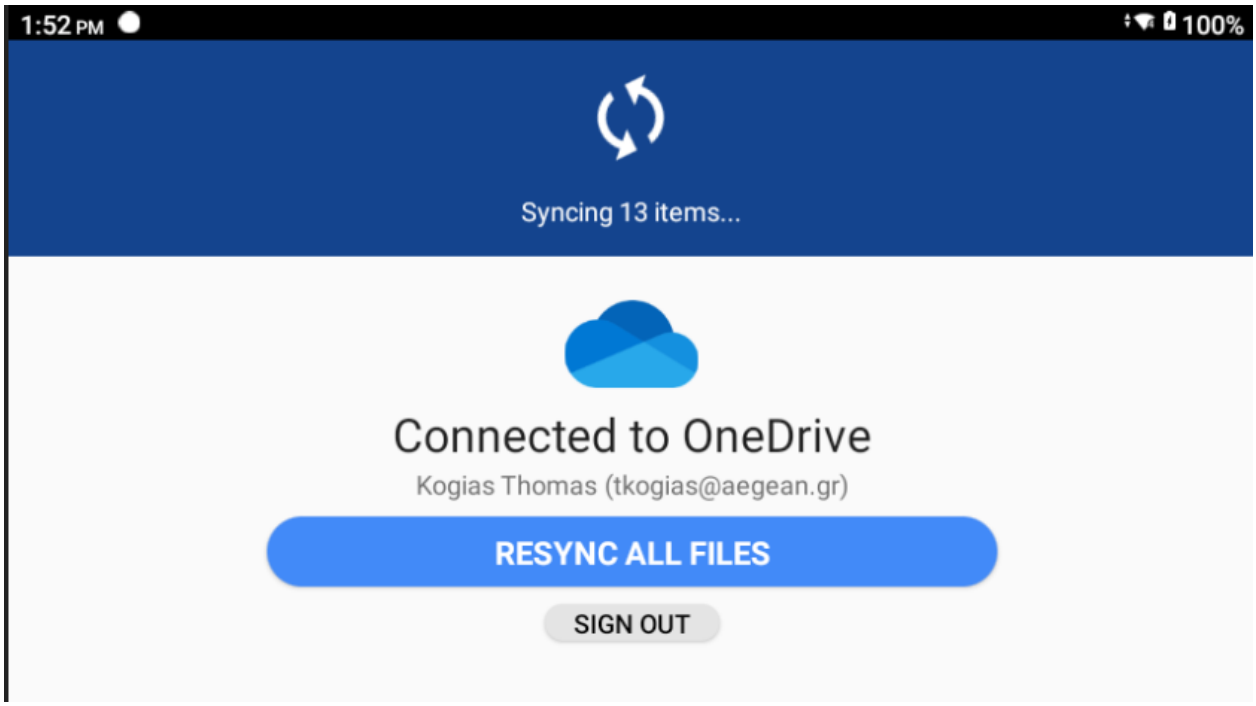
Select `RESYNC ALL FILES`

A message pops up, informing us that the procedure might consume significant bandwidth, as all media files will be uploaded. Select `OK`.



Select OK (time taken will depend on number/size of media files and available bandwidth).

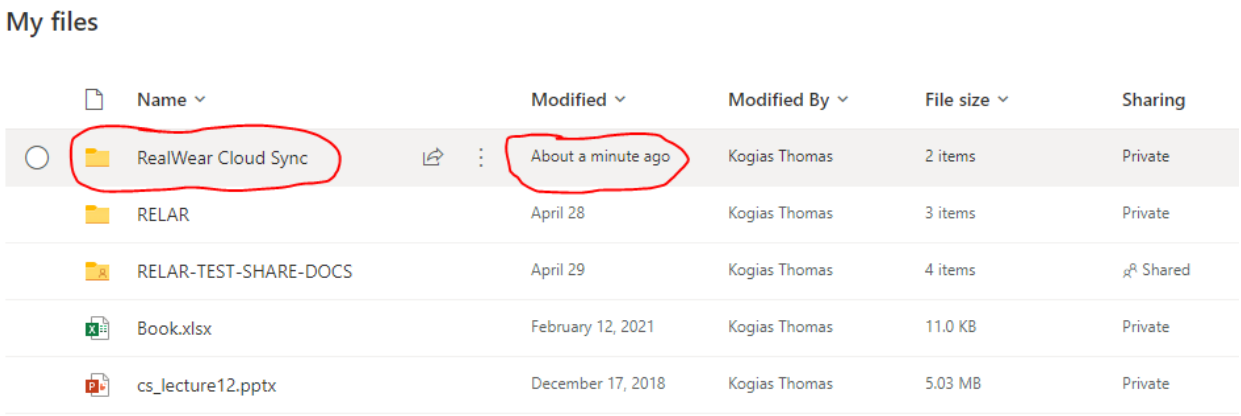
Syncing starts:



Media files are being uploaded (syncing)

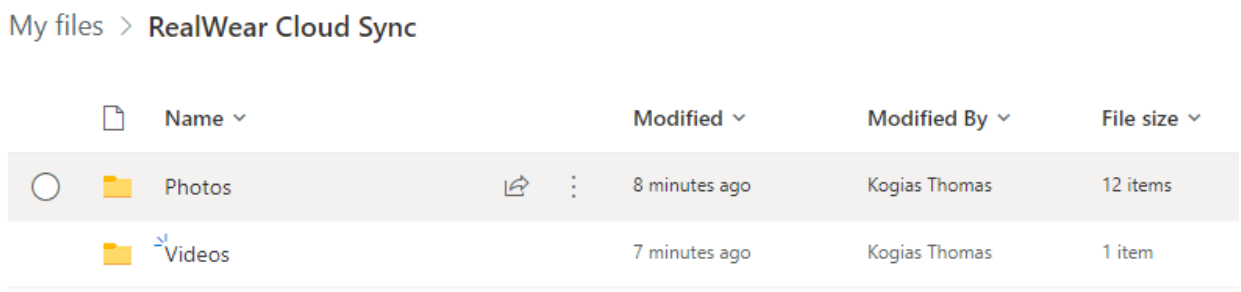
Important notice - First time use:

If this is the first time uploading media files from the HMT-1 to the specific OneDrive account linked with the device, an appropriate folder named “RealWear Cloud Sync” will automatically be created in the root folder structure of the OneDrive account. The screenshot below, captured from OneDrive’s web interface confirms the folder creation:



Root OneDrive folder as seen from a WEB UI. Folder automatically created.

Once syncing completes, media files are split into videos and images, and are available (shared) with the OneDrive user:



Media files (photos & videos) have been uploaded and are now shared within OneDrive

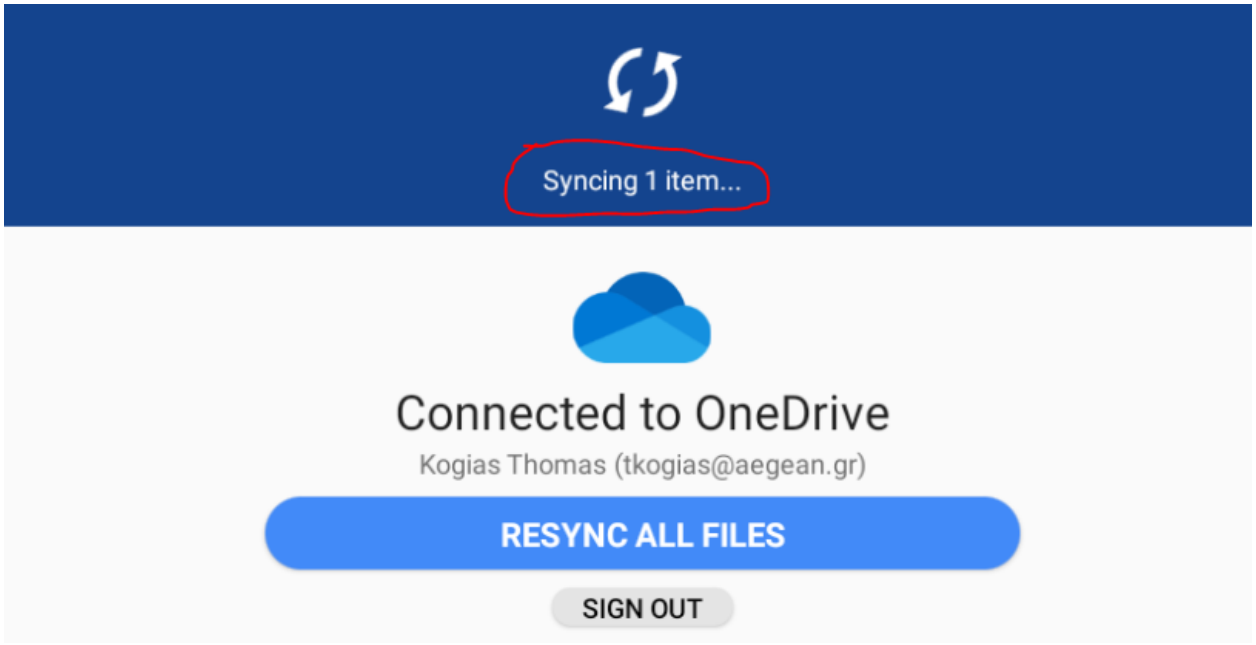
Subsequent uploads are automatic:

Please note, that re-syncing all files is not necessary for subsequent uploads to the specific OneDrive account linked with the Device. As the `CLOUD SYNC` app notifies the user, nothing is left

to Sync, and the user may simply "**capture photos or videos from 'My Camera' to start uploading**".

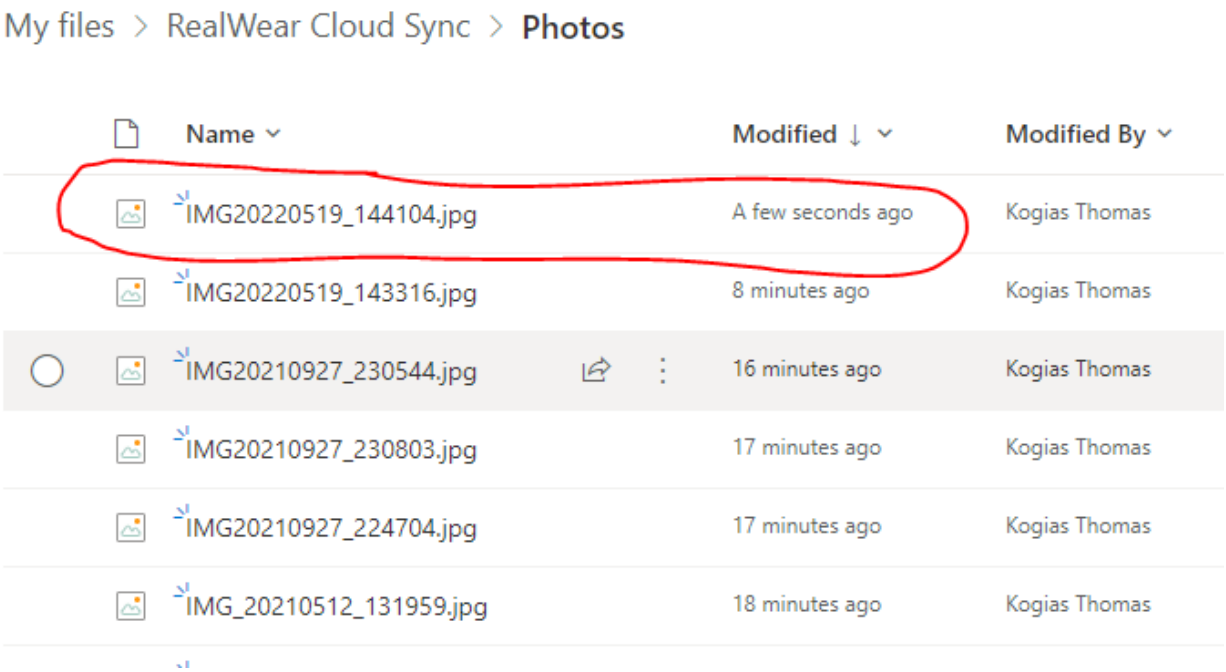
As an example, open up `HOME SCREEN` -> `MY CAMERA` and then select `TAKE PHOTO` to capture an image.

Once a photo is taken and saved in the device, uploading to the designated OneDrive folder begins automatically in the background. To confirm this, user may open up the CLOUD SYNC app and (if uploading has not completed yet) an appropriate message is showing that 1 item is being synced:



Automatic upload of newly captured image has already begun

Indeed, the recent photo is automatically shared within OneDrive (inside RealWear Cloud Sync -> Photos):



Conclusion:

Once HMT-1 is linked to a specific OneDrive account, and once an initial sync has taken place, new images and videos taken with that device will automatically be shared in the designated OneDrive folder and can be thereafter utilized in multiple ways.

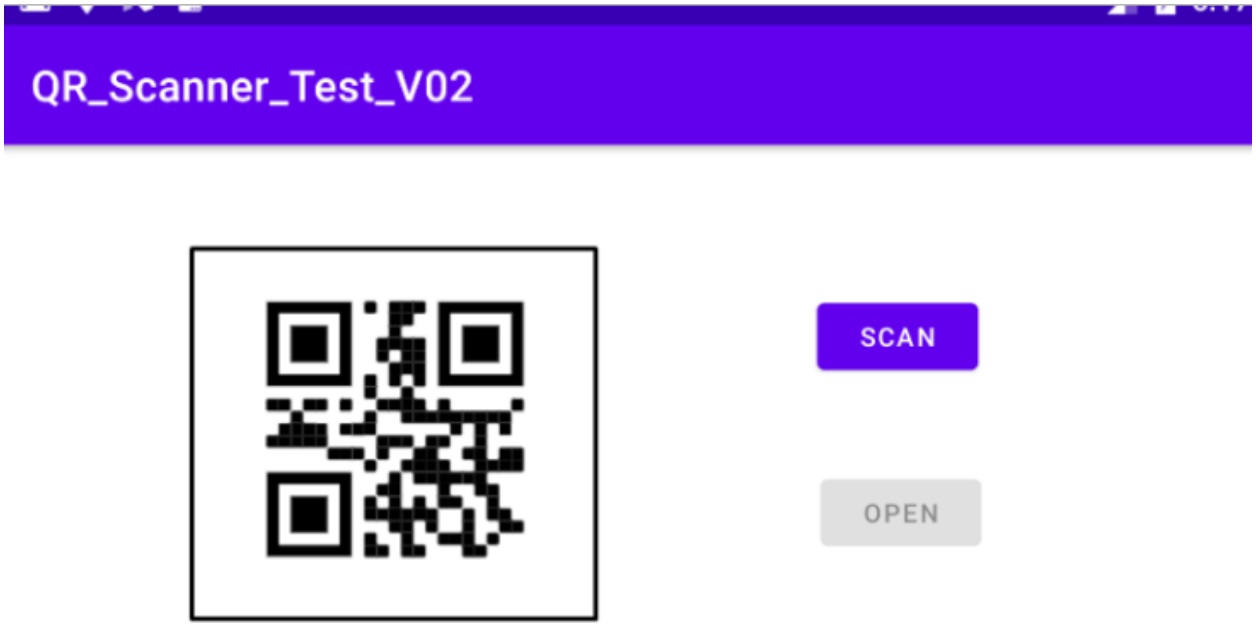
7. Leveraging the use of QR Codes using the HMT-1

A custom RELAR app is under development and will facilitate the use of QR codes as an easy shortcut to files via the use of the encoded URL containing the file's network address. Some of the benefits of using QR codes are:

- Free online tools (e.g. www.qr-code-generator.com) for easily creating custom QRc for any scenario.
- Easily recognizable, so it can be used in non-perfect situations without any additional skills.
- Convenient to use in a plethora of scenarios as QR codes can be created and then printed onto paper and/or stickers to be used in labs/classrooms etc.

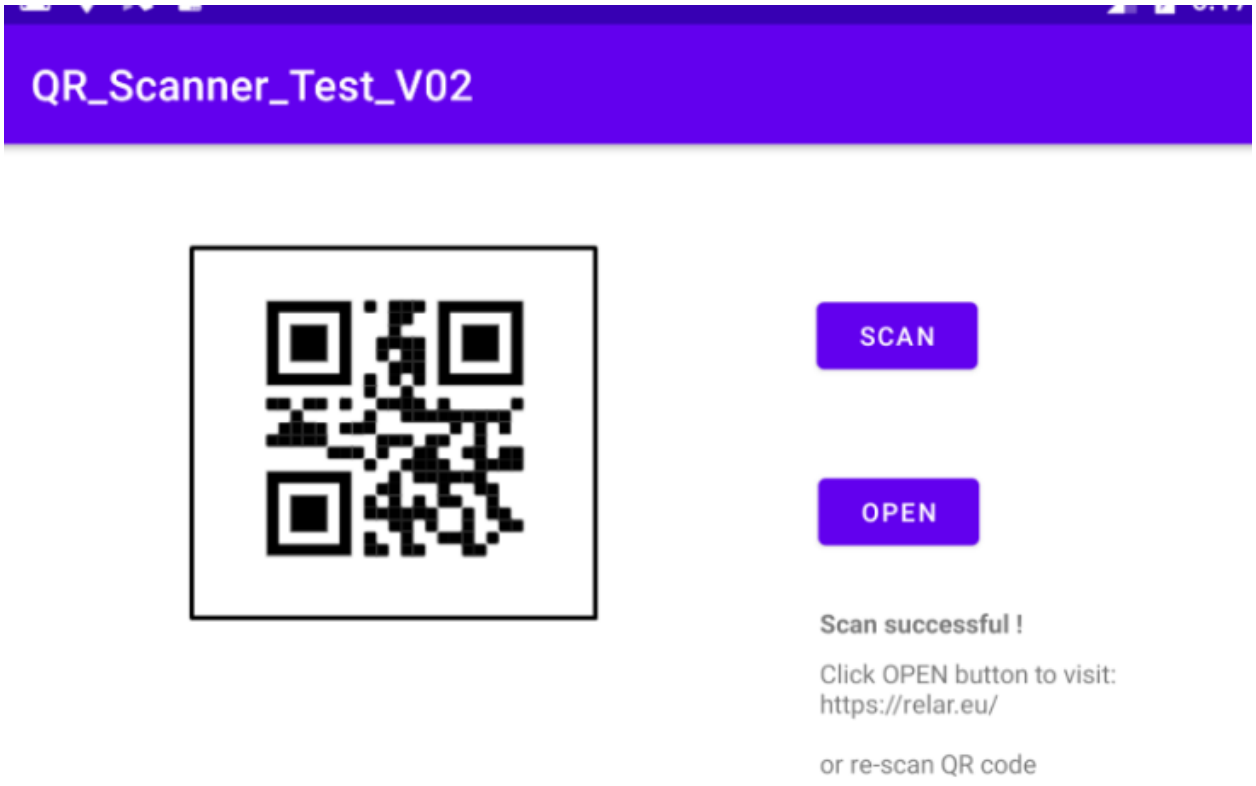
High-level description:

The HMT-1 user opens up the RELAR app and is prompted to scan a QR code:



Step 1 - RELAR custom app, scanning a QR code

Once a QR is scanned successfully, the user is informed about the destination (URL) and can either follow it by selecting the (now enabled) OPEN button, or re-scan another QR code.



Step 2 - Open destination URL or re-scan

Note:

Further features are currently being investigated, and their development will be decided after further consultation with the scenario-building partners.

Specifically, such features may be:

- The ability to store all previous scanned QR codes in a local repository within the device.
- The ability to leverage libraries such as ZXing[3] and also provide access to local files/folders via appropriately created QR codes.
- The ability to store short texts (roughly up to 4000 characters), perhaps containing instructions or other simple messages.
- Use the QR code as part of a verification step throughout a login process.

[3] https://github.com/zxing/zxing

8 - References

HMT-1 general documentation:

- HMT Setup guide - https://support.realwear.com/knowledge/hmt-setup-guide
- RealWear explorer - https://support.realwear.com/knowledge/realwear-explorer
- Cloud Sync APP - https://support.realwear.com/knowledge/cloud-sync
- Using the HMT-1 - https://support.realwear.com/knowledge/using-the-hmt
- Latest firmware release notes - https://support.realwear.com/knowledge/release-12.2-firmware-release-notes

HMT-1 app development documentation:

- HMT development examples - https://support.realwear.com/knowledge/hmt-development-examples
- WearML embedded - https://support.realwear.com/knowledge/wearml-embedded-tutorial
- WearML embedded API - https://support.realwear.com/knowledge/wearml-embedded-api
- ZXing library - https://github.com/zxing/zxing