WeCount: Citizens Observing UrbaN Transport

Deliverable 3.2: Final WeCount Platform and Sensor Kits - DEM

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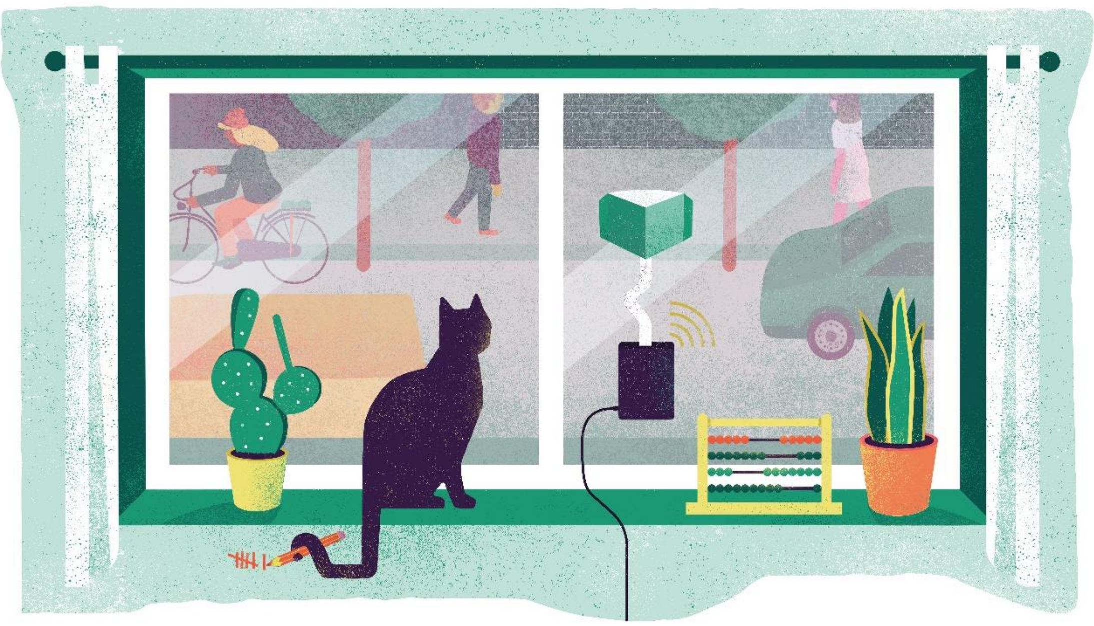
Author: Kris Vanherle, Carl Van Poyer, Veerle Vranckx, Willem Himpe, Dave Driesmans, Anna Molter, Ben Williams, Enda Hayes



The WeCount Project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 872743

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Authors	Kris Vanherle
Contact	Kris Vanherle
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V3.0	Kris Vanherle	25/5/21	Final edits

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1 Introduction

WeCount, Citizens Observing Urban Transport, is a Horizon 2020 funded project that is part of a Science with and for Society (SwafS) call (H2020-SwafS-2018-2020). WeCount is a Citizen Science project working in five cities in Europe to empower citizens to take a leading role in producing data, evidence, and knowledge around mobility in their own neighbourhoods and at the street level.

The project applies participatory Citizen Science methods to collaboratively develop and deploy innovative, low-cost, automated traffic counting sensors (i.e. Telraam Sensor) and multi-stakeholder engagement mechanisms in five case studies in Leuven (BE), Madrid and Barcelona (ES), Cardiff (UK), Dublin (IE) and Ljubljana (SI). The five cases follow a similar execution path, with Leuven & Madrid (and Barcelona) leading off and serving as a test case for the remaining three cases. Following this approach, WeCount aims to quantify local road traffic (cars, trucks, active modes, and speed), produce scientific knowledge in the field of mobility and pollution, and co-design informed solutions to address a variety of road transport challenges. In addition, the project provides cost-effective data for local authorities on a much larger temporal and spatial scale than would be possible with traditional traffic counts, opening up new opportunities for transportation policy and research.

To achieve this, the existing Telraam sensor and platform operate as the technical mechanism to generate and process the data and to manage the technical aspects of devices installation. In WeCount, the existing Telraam sensor and platform was already established and therefore were rolled-out as-is and subsequently improved during the project lifetime with an emphasis on user-friendliness and aim to "de-tech" the technology, to achieve a wider diversity of Telraam users. An initial upgrade was completed in month 6 of the project and reported in D3.1 "Final WeCount platform and sensor kits" (May 2020). During the case studies, feedback from project partners and Telraam users was collected to continuously improve the sensor and platform. D3.2 reports on the changes and concludes this process.

D3.2 "Final WeCount platform and sensor kits" is a demonstrator deliverable. As such, this report does not aim to describe in detail the platform and sensor functionality. The (final) sensor and platform are the deliverable. This report briefly documents key new features and improvements that were done compared to the initial platform and sensor at the beginning of the project (D3.1).

The focus of the report is mostly on the platform improvements and secondly on the sensor side. For the former, compared to D3.1, the platform was expanded to enable data-extracts and the addition/improvement of user and network-manager data dashboards. For the latter, most of the improvements relate to sensor robustness.

2 WeCount Platform

2.1 Starting point: the initial platform

Telraam (www.telraam.net) was the starting point. The link to the WeCount website is the following URL: https://we-count.net/home

We established the central platform of the citizen science activities in WeCount. This platform includes the front-end website, the back-end data-storing and -processing and supports the engagement activities throughout the project.

The WeCount platform focuses on easy access to hands-on tools needed to execute the citizen science activity (WP4), in particular the handling of the sensor-data (receive, process, store, front-end dashboard).

This required some web development (user interface) and we simplified the “dashboard”, build an adaptable dashboard for a range of users from transport scientist wanting to use the data to non-tech concerned citizens, interested in easy to understand transport indicators. The current Telraam platform holds these features, but we made some adaptations and improvement to increase user-friendliness.

The Platform includes a member registration and management platform. Involving citizens via the platform via this flow:

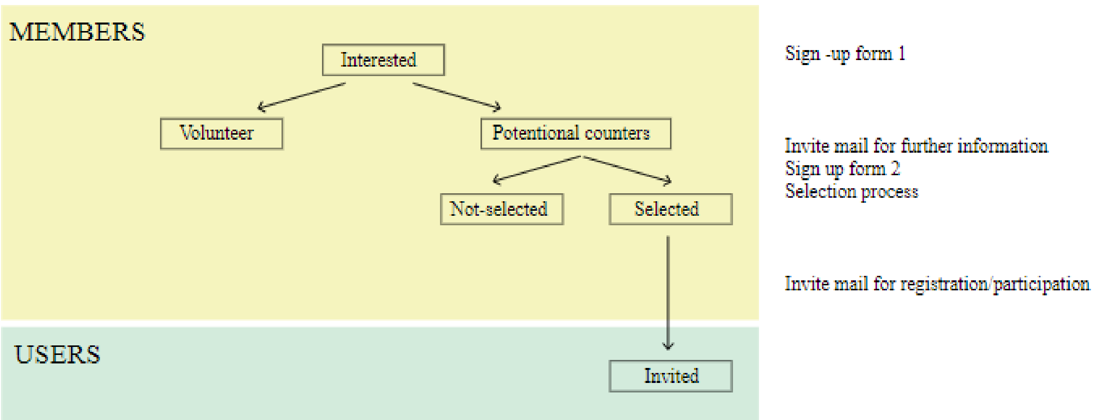

Figure 1: User-flow in the Telraam/WeCount management platform

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Some impression below:

The dashboard

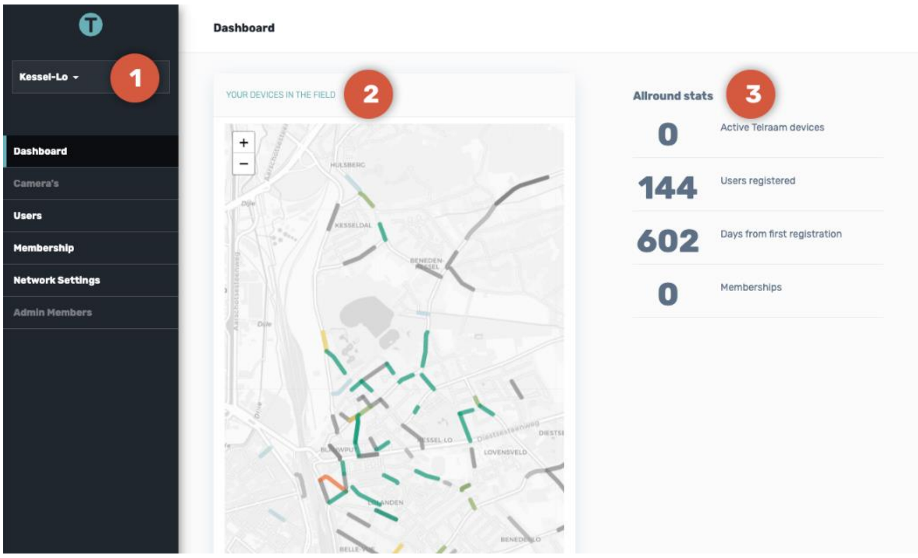

Figure 2: Screenshot of the network management dashboard landing page

1. Select the network you have access to in the top left from the pull-down menu
2. Showing the map of the network with relevant segments
3. Dashboard showing statistics with relevant segment and user statistics.

Users

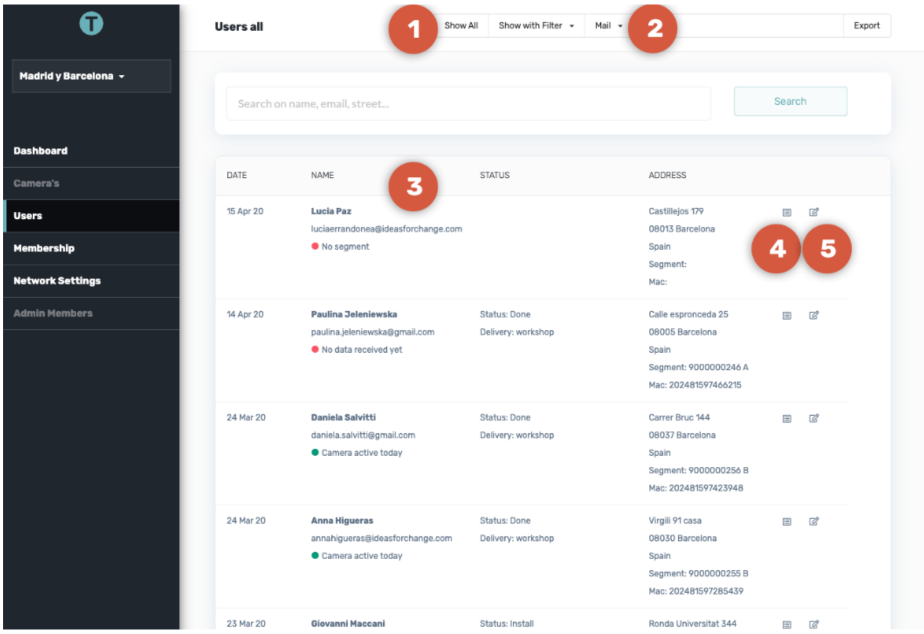

Figure 3: Screenshot of the network management dashboard user-details page

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You see a list of all users that belong to your network, including the status of their setup process and, when fully set-up, their camera. With some specific functionality:

1. Filters for the users
2. Functionality to send users a batch email
3. The overview with all details at level of the user
4. A link for each user's action log
5. A link to the user details and mail history

Membership

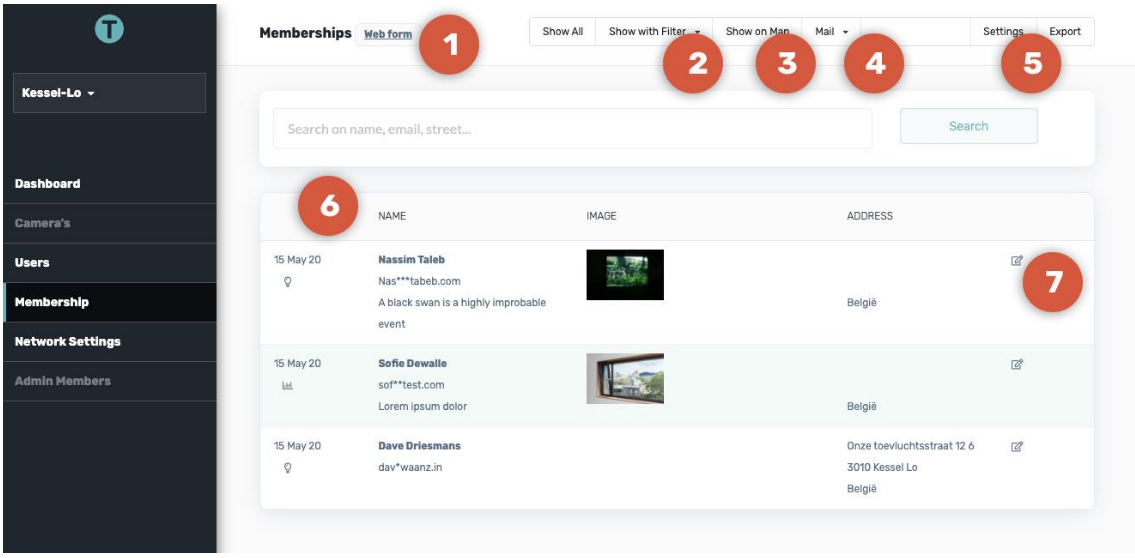

Figure 4: screenshot of the network management dashboard member-details page

1. The link to sign-up form 1,
2. Filters for your members
3. A map of the members with dots based on the address
4. Functionality to send members a batch email, including several template mails
5. Settings for both sign-up forms
6. The overview with all details at level of the member
7. A link to the member details and mail history

A tutorial was developed for use within the consortium: https://telraam.net/en/how-to/network-admin

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2.2 Additions/improvements to the platform since D3.1

As with the initial platform, the final platform builds further on the starting point, i.e. the Telraam-platform of www.telraam.net

2.2.1 *Improvement to the user management*

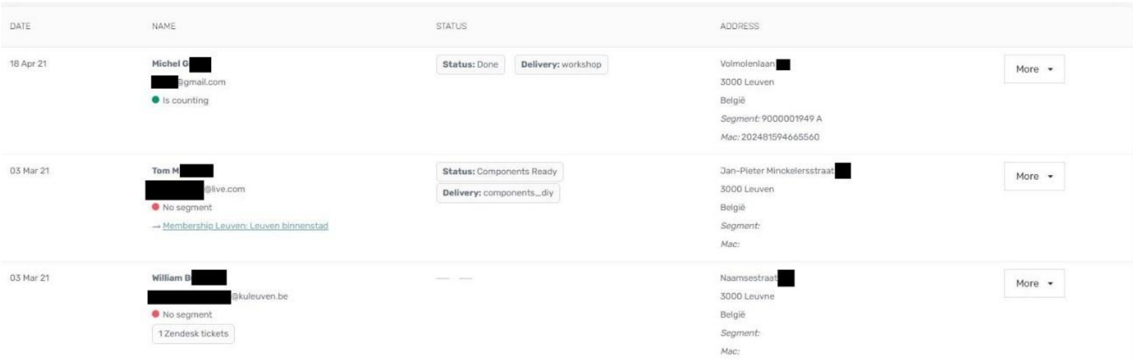

Figure 5: Screenshot of the network management dashboard user-details page with additional information at user-level.

Several additions have been added to visualize the status of each user in the sensors installation:

- Direct overview of user information in a single page in the user tab
- Integration with the Zendesk helpdesk system (i.e. using Zendesk API to directly show if there have been any questions raised by the users via the support system)

More elaborate user details are included:

- Details of the current active Telraam, time of installation and time of last data received
- Diagnostics from the sensor logs to allow for fast remediation in case users experience a technical issue. More details in the section on the sensor
- Inclusion of a heavily pixelated background image to review if the camera is still correctly oriented.

All these features allow the network manager to manage the sensor installation and follow-up of users with technical issues post-installation in a more efficient way.

2.2.2 *Addition of a network data dashboard*

While the emphasis of the initial platform was to facilitate the onboarding of Telraam sensor users, which was further improved (see previous section), the emphasis in the development to the final platform was data management and presentation.

First, from the perspective of the network manager, an intuitive data dashboard was added. The dashboard landing page was improved to have glance overview of the status of the network, see example below for the sub-network in Leuven City Centre (one of the 5 WeCount networks in the Leuven case study):

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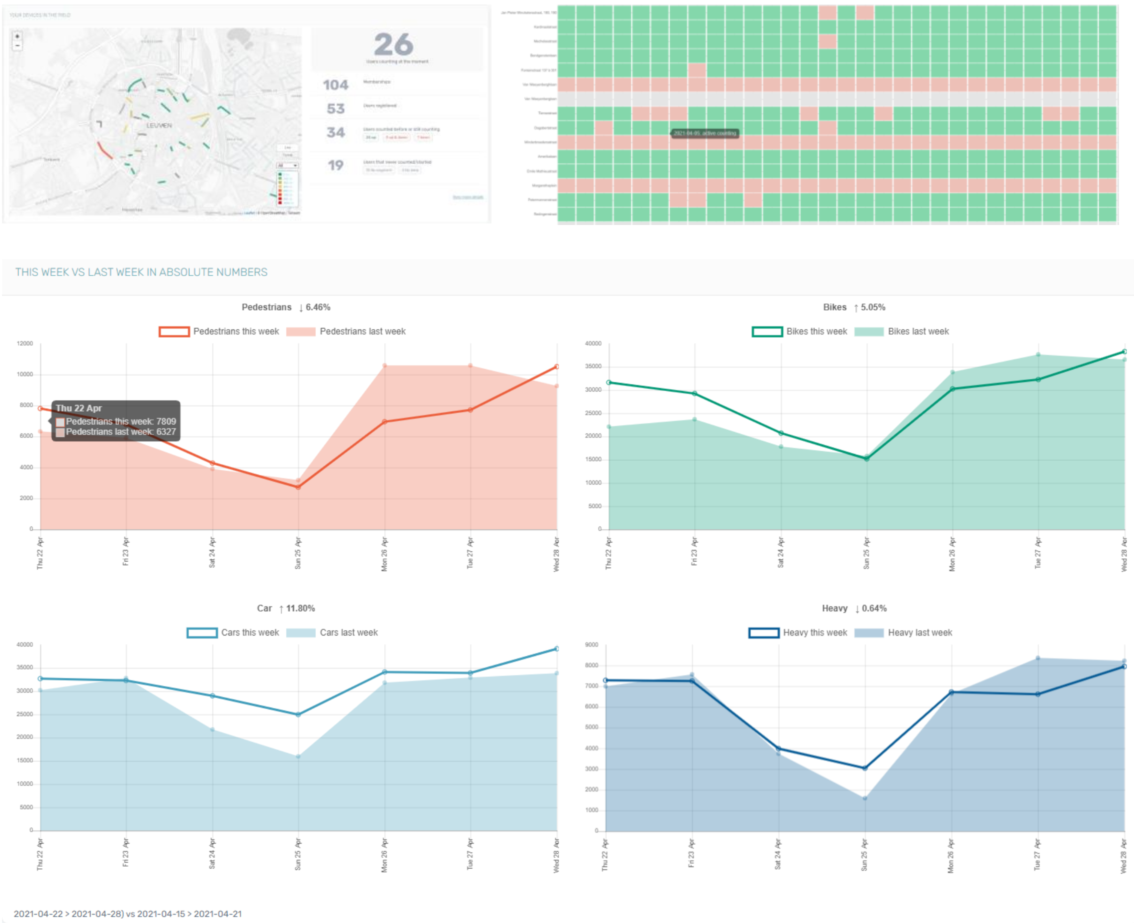

Figure 6: Screenshots of the network data dashboard

In April 2021, a final addition was made with network total volumes to allow for 2 types of (high-level) analysis:

First, trend analysis at network-level, comparing actual traffic volumes to the typical volumes:

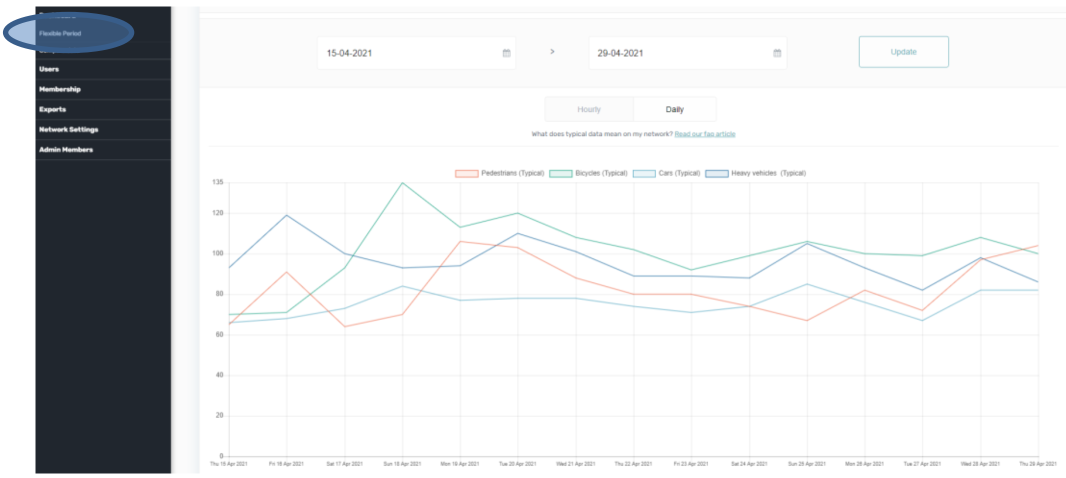

Figure 7: Screenshot of the network data dashboard – trend analysis

Secondly, a tab to compare total/typical/relative traffic volumes for the full network or a selected segment:

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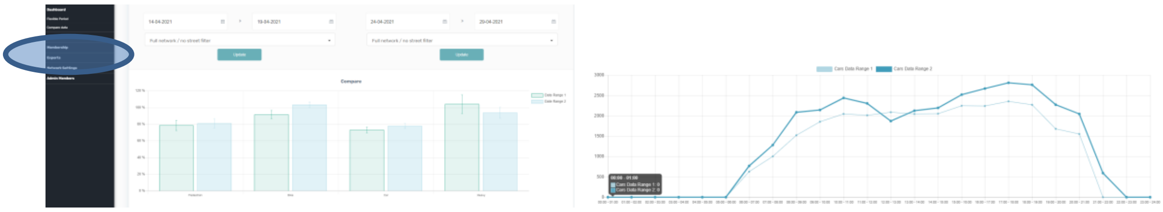

Figure 8: screenshot of the network data dashboard - comparing data

These addition were done at the end of the development cycle, so most of the data analysis in the case studies in WP4 either used the newly included exported data functionality or the improved API. (see below)

2.2.3 Data Exports

In the initial platform, data-extract were only possible via the basic API. In the period Nov '20- mar '21, data exports were added to the platform, both for the network manager (for data in the full network) as well as the user (own sensor only)

Data exports are computational heavy for the database and are thus managed as a "job-based service". Network managers can acquire either raw sensor data, or processed data for each sensor in their network, on a monthly basis. Users can do the same for their own device. Data is dumped in an Excel file which requires several minutes to be generated. A downloadable file is produced for the network manager or user to download.

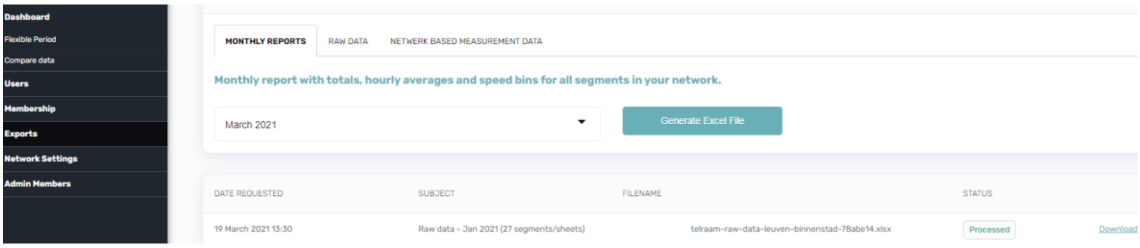

Figure 9: Screenshot of the network data dashboard - data exports

The data format holds data per hour (each row), limited segment information and includes traffic counting data (totals per direction) and speed-bins (% per 10km/h interval).

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Segment I	Street	City	Date	Pct_up	Pedestriai	Pedestriai	Pedestriai	Bike (A > E	Bike (B > A	Bike Total	Car (A > B	Car (B > A
2	349570	Vital Decc	Leuven	2021-01-0	0	0	0	0	0	0	0	0	0
3	349570	Vital Decc	Leuven	2021-01-0	0	0	0	0	0	0	0	0	0
4	349570	Vital Decc	Leuven	2021-01-0	0	0	0	0	0	0	0	0	0
5	349570	Vital Decc	Leuven	2021-01-0	0	0	0	0	0	0	0	0	0
6	349570	Vital Decc	Leuven	2021-01-0	0	0	0	0	0	0	0	0	0
7	349570	Vital Decc	Leuven	2021-01-0	0	0	0	0	0	0	0	0	0
8	349570	Vital Decc	Leuven	2021-01-0	0	0	0	0	0	0	0	0	0

Figure 10: Screenshot of exported data in MS Excel

The data extract functionality was first implemented on a per-request basis and released as a common feature in early March 2021. The amount of exports has been recorded since March 9th:

1. **134** Data-Exports generated by network managers, in period March 9th to April 28th
2. **302** Data-Exports generated by single users, in period March 9th to April 28th

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2.2.4 User dashboard – monthly report

For better user engagement in data interpretation, an intuitive monthly report was designed and released in November 2020. It includes both the "sensor health" i.e. if the own sensor has been counting as well as data-indicators.

First, sensor health includes a per-day overview of the quality label of the counting data. Properly functioning devices should have a low share of "poor" and a share counting / not-counting coinciding with daylight. An overall assessment is given in a 5-scale indicator "sensor activity". See example below for a sensor in steady operation.

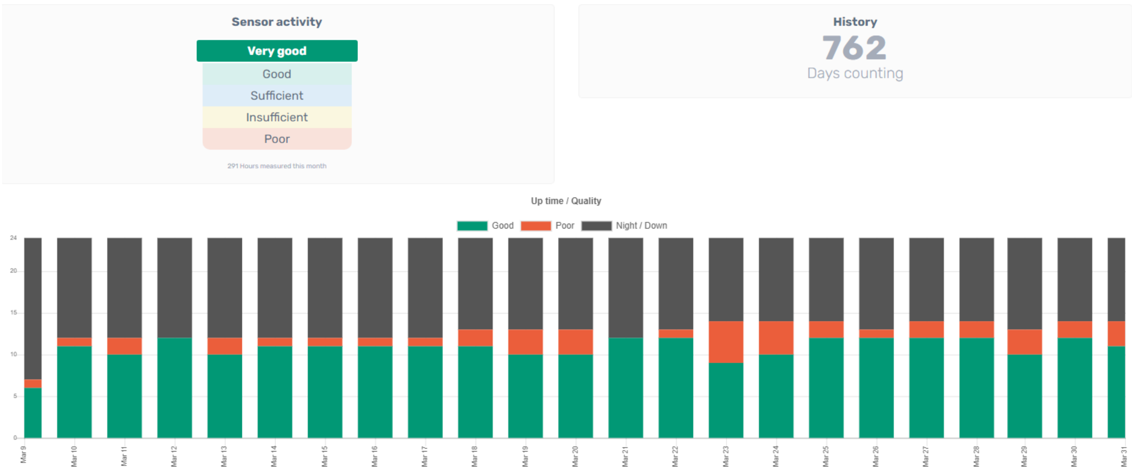

Figure 11: Screenshot of the user's monthly report – landing page

Secondly, the monthly report shows high-level data and trend vs. the previous month, for all modes. The top 10 busiest hours in the previous month are shown and the total share of cars per speed bracket of common speed limits (30, 50, 70km/h) is presented:

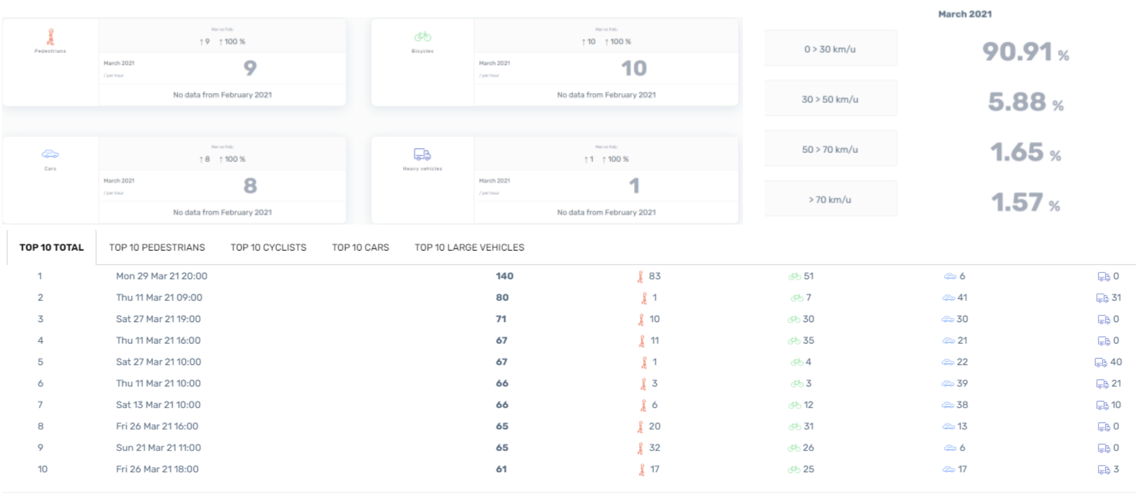

Figure 12: Screenshot of the user's monthly report – comparing periods & trend analysis

The realization of this dashboard was done in close interaction with 2 pilot cases, in particular with users in the Leuven case. Features were gradually added and adapted, building on user feedback in the workshops organized in WP4.

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2.2.5 User dashboard – setup & camera images

An improved interface was made to allow the user to review their setup in their own personal dashboard. From the Leuven & Madrid cases, it was evident that it was not easy for users to adapt the installation (e.g. replace the sensor, select a new road segment, review if camera-position is still correct).

Two extra tabs were created in the user dashboard, allowing users to easily review and update their setup, with instructions and warning messages in case something needed to be updated (e.g. correct a typo in the sensor serial number). This addition has led to a decrease in helpdesk tickets.

The sensor upgrade of July 2020 (see further) also allows users to check the camera image on their own dashboard, after logging in to www.telraam.net. To avoid breach of data-protection rules, two measures were taken:

- We take a background picture for a period of 30 seconds and take the average value for each pixel for that period. Moving objects are therefore not visible.
- We convert the background image to a (very) low resolution, by "pixelation". The resolution is sufficiently high to be able to estimate whether the camera position is still good, but the resolution is so low that people are not recognizable in the image.

Example of image below:

Figure 13: example of background image

Only the own Telraam-user and the Telraam network managers have access to these images. The images are not published and automatically deleted after 7 days.

By applying these two techniques, the privacy of passers-by is safeguarded and users or network-managers can still easily check if your camera is still properly oriented.

This feature was requested by several users, to generate a much more simplified way and required a lot of modifications both on the sensor software as well as the platform.

2.2.6 Ensuring Privacy

With respect to privacy concerns of some participants, we translated & published the assessment of the Belgian Data protection Agency (Gegevensbeschermingsautoriteit - GBA) on Telraam on our FAQ and have proactively shared with participants to alleviate any potential concern: https://telraam.zendesk.com/hc/en-us/articles/360025746472-What-about-privacy-

Although camera-based, the Telraam sensor is an example of "privacy by design" by using edge-computing techniques. No live video feeds are transmitted to a central database for processing; all visual processing is done instantaneously on each individual device and converted into object-properties. It is impossible for anyone to consult a live video stream from Telraam when the device is in operation, not by the central controller nor the local device owner.

This is done both out of necessity as the hardware platform lacks performance to maintain the required frame-rate if data-transmission of a video stream was included, as well as to preserve privacy of passers-by.

The only time a live video-feed can be consulted, is if the device is in Hotspot-mode, for setup, which requires a wifi connection to the device and thus a local presence.

To further safeguard privacy, also after the addition of collecting background image, we added pixilation & median value of 30", to avoid capturing moving objects (detail above).

2.2.7 API

A data-API was available for all Telraam data at the beginning of the project. In the period November '20 - March '21, the database of sensor data was migrated to an AWS-environment. This required the API to be built from scratch on the new database.

Most relevant data end-points were maintained in the new API (e.g. post "traffic") and supplemented with extra data such as V85.

The new API is more robust and includes load management via the use of tokens. This was needed as the original database experienced several outages as a result of overload from (unknown) API query calls.

Most importantly, the new API (v1.2) has a complete documentation of the end-points, allow technical users to be able to extract the data without any need for further information from the Telraam-team or WeCount-partners.

Full documentation of the API is available via www.telraam-api.net with Postman: https://documenter.getpostman.com/view/8210376/TWDRqyaV

There are several examples of WeCount/Telraam users that have built their own dashboard with this API, for example:

Figure 14: Example of an user-built dashboard, using the Telraam API

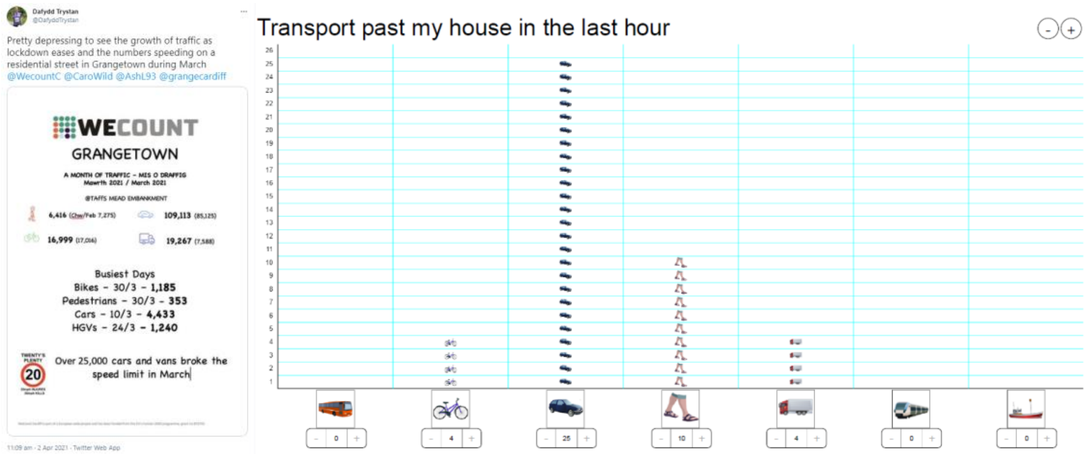

Figure 15 - Example of two user-generated visualisations of Telraam data from Cardiff (left: a local community champion; right: a 11-year old for a school assignment)

2.2.8 Public website

With the development of further data processing, it is now also possible to distinguish in typical traffic volumes per day type: weekday/weekend. An intuitive interface was added to the public website, allowing users to select all days, weekday's or weekends:

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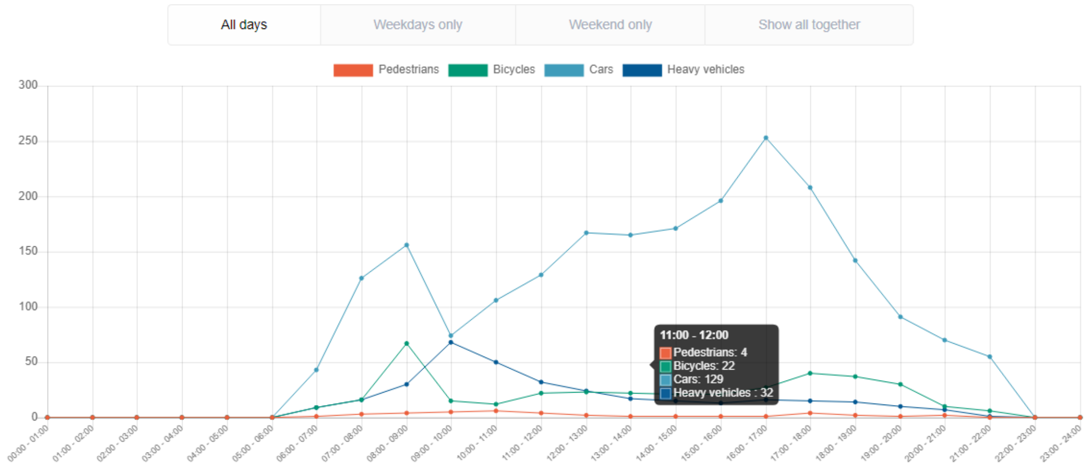

Figure 16: Screenshot of typical traffic on the public website

2.2.9 Miscellaneous

The backend received an important update towards camera “instances”. In the past we couldn’t for example save a camera history and there was a risk losing important historical data. We solved this with the concept of camera instances. This feature had a big, overall impact on the code but was almost invisible for the daily users.

The directions are indicated more clearly in the visualizations. In the selection on the map, the location pages and the visualizations, we show consistently point A and B, the beginning and end of a street segment. The directions are indicated in such a way that we maintain the privacy of the users.

It’s now also possible to correct a wrong Telraam position - its street segment and/or side of the street - with a retroactive effect. Telraam will recalculate this date. If you physically relocated your Telraam device you can start a new setup with the same device.

We improved the user-friendliness of the online setup. The setup is done in six steps with detailed explanations. Both at the beginning of We Count and after a full year of feedback, numerous small improvements have been made to the setup.

An outboarding feature was added, for participants that stopped participating in the project.

Finally, the FAQ (https://telraam.zendesk.com/hc/en-us) has received a major update. The list of FAQ’s was extended as more feedback was gathered from the end users. In February, a major restructuring of the FAQ was implemented primarily to rearrange then to fit the user experience and make the appropriate support more logical and easier to find. Obviously, the FAQ content will continue to be updated.

All changes to the platform are logged in the changelog: https://telraam.net/changelog.txt

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3 WeCount Telraam Sensors

3.1 Starting point: the initial sensor

The central data platform serves as a basis to receive, process and report data from a range of autonomous sensor data from the citizen science activities.

As indicated in the initial sensor, the starting point is the Telraam sensor. For the initial version, we simplified the existing sensor tool, focusing on ease of installation and user interactions.

Again, the emphasis in WeCount, throughout the project is to reach a wide range of citizens, not just tech specialists. The further development of the existing sensors -if needed at all- is focused on ease of use.

The original Telraam Raspberry-Pi based sensor was kept as the hardware platform. Telraam already has an "install and forget" approach, though ease of installation could be improved, so we did e.g. captive WIFI, procurement as a finished product instead of self-assembly, software installation.

We selected sensors that are proven to work in previous applications (e.g. Telraam, NO_2 sampling tubes, etc.). These sensor toolkits were used in the two pilots in Leuven & Madrid.

Figure 17: Telraam sensor as installed

Components:

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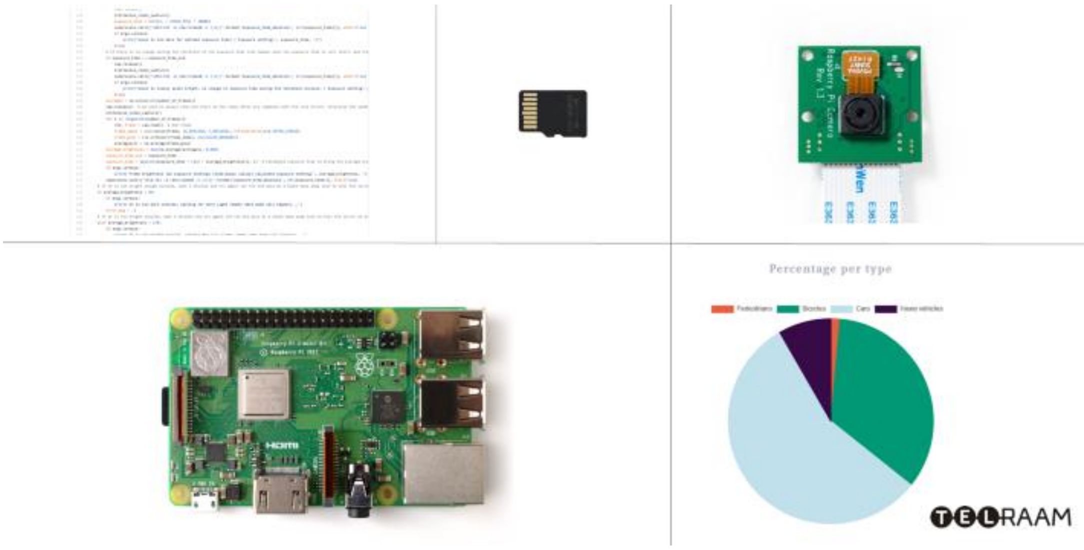

Figure 18: Telraam components Clockwise starting top left. [1] Software code, [2] SD-card, [3] Raspberry Pi camera module, [4] Rapsberry Pi, [5] Data platform

3.2 Air quality sensors

Air quality is monitored using the Smart Citizen Kit 2.1 (SCK2.1) (Camprodon et al. 2019[1]). SCK2.1 is the commercially available version of SCK2.0, which was developed during the EC H2020 funded iSCAPE (Improving the Smart Control of Air Pollution in Europe) project. SCK2.1 is designed in an extendable way, with a central data logger (the Data Board) with network connectivity to which the different components (the Urban Sensor Board) are branched (Fig X[2]). The system is based on the principle of reproducibility, also integrating non-hardware components such as a dedicated Storage platform (Fig X[3])and a Sensor analysis framework. The base configuration of SCK2.1 will be used, which measures air temperature, relative humidity, noise level, ambient light, barometric pressure and particulate matter (PM). Table 1 lists the sensors installed on the Urban Sensor Board.

Table 1: Sensors used on the Urban Sensor Board

Measurement	**Units**	**Sensors**
Air temperature	°C	Sensirion SHT-31
Relative Humidity	% REL	Sensirion SHT-31
Noise level	dBA	Invensense ICS-434342
Ambient light	Lux	Rohm BH1721FVC
Barometric pressure	Pa	NXP MPL3115A26
Equivalent Carbon Dioxide	ppm	AMS CCS811
Volatile Organic Compounds	ppb	AMS CCS811
Particulate Matter $PM_{1/2.5/10}$	$\mu g/m^3$	Plantower PMS 5003

[1] https://doi.org/10.1016/j.ohx.2019.e00070

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Data collected by the sensors is automatically uploaded to an online data storage platform (https://smartcitizen.me/kits/). The measured data, as well as the hardware specifications, software and sensor post-processing algorithms are openly accessible.

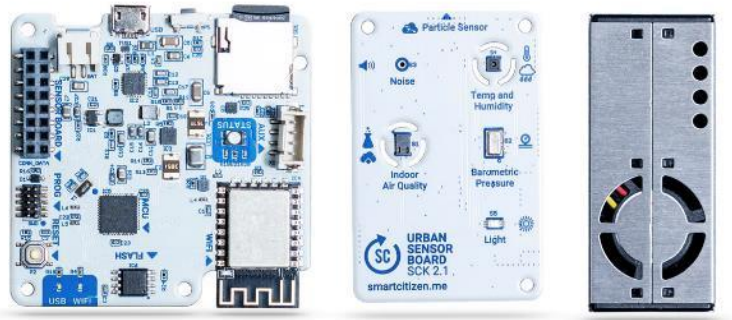

Figure X: Smart Citizen Kit 2.1 clockwise starting left. [1] Outdoor installation of SCK2.1 [2] Data Board and Urban Sensor Board [3] Smart Citizen Platform

For quality assurance purposes one SCK2.1 will be installed next to regulatory air quality monitors operated by Ireland's Environmental Protection Agency in one of their Dublin air quality monitoring stations (https://airquality.ie/station/EPA-33). These sensors will also be deployed alongside Telraam sensors in Cardiff to understand the relationship between traffic and local air pollution. As with Dublin, one sensor will be collocated with an EU reference method analyser based beside the UWE campus.

3.3 Additions/improvements to the Telraam sensor since D3.1

As with the emphasis in the deliverable of the initial sensor in D3.1, the focus is to "de-tech". This has resulted mostly in gradual upgrades to the software to improve sensor robustness and to lesser extend the hardware design. The interaction with Telraam users in the context of WeCount was extremely valuable to define clear specifications of a to-be-developed new sensor. This has led to the start of a new project, to develop this sensor.

3.3.1 Software updates for robustness

First of all, various improvements were made to improve the sensor robustness.

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Most of these efforts were done in the background and unaware of the Telraam-users. During WeCount, we've learned a lot about root causes of software issues with the sensors and we've tackled them gradually.

The most important addition, is the ability to capture single, pixelated camera-images, to review if sensor placement is still ok. Details are discussed in the previous section. We added a separate script to generate and transmit heavily pixelated background pictures and implemented this in a new version of the software: v11

We added a list of diagnostics of frequently occurring issues:

1. **Camera hardware fault**: in principle, hardware defects are rare, but if they occur, it is mostly due to the camera lens. We added logging of error-messages to allow remote diagnosis.
2. **SD-corruption**: rare, but more frequently is SD-card corruption while in operation (due to extensive read-write operations). We added logging of stack traces.
3. **Wifi signal strength**: a frequently occurring issue is that Telraam-sensors are installed on the edge or outside of wifi-range. An annoying problem for the user as it's hard to identify the problem without information on signal strength. We used the signal strength monitoring of the Raspberry Pi (the Telraam hardware platform) and applied a conservative threshold value to generate an alert if wifi-range could be an issue.
4. **Wigi 5Ghz**: there is a lot of evidence that the Rapsberry Pi doesn't function well on the 5Ghz wifi band (e.g. https://www.raspberrypi.org/forums/viewtopic.php?t=261777). It took us a long time to understand this issue was also occurring in the Telraam devices. We added an alert message if the device is connected to 5Ghz, which in principle isn't a problem but would be the likely cause if connection issues occur. We are currently implementing an adaptation to force connection to the more stable 2,4Ghz band.
5. **Undervoltage**: the Telraam-sensor requires a 2,5Amp power adapter. Although we use 2,5Amp outlets, if they are not certified by Raspberry Pi, this can be cause for undervoltage events that will freeze the monitoring scripts. We added logging of error-messages to allow remote diagnosis and replaced power adapters.

Diagnostics are collected per user and presented in the dashboard. See example below:

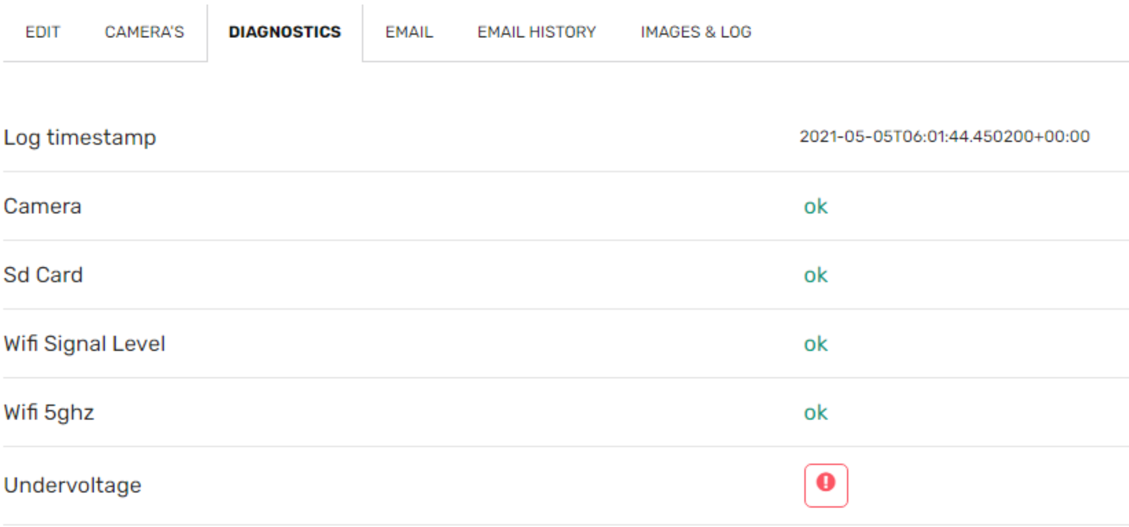

Figure 19: Screenshot of the user-diagnostics interface in the network management

We've managed to implement upgrades via various Over-The-Air (OTA) updates. There have been no software releases that required a physical re-installation of the software which would be cumbersome for the users.

A final update was a modification of the master script with various safety-checks to ensure an automatic restart of the monitoring script in case a fluke error caused a freeze. This addition is a final OTA update implemented in April-May '21

It should be noted that the role of some WeCount participants in this process has been key to solve some of these problems. As it was hard to reproduce most of the errors in our lab-environment, feedback from tech-savvy users, experiencing issues in the field and their ability to provide full technical documentation of the errors (e.g. extracting logs from the sensor locally) has proven to be invaluable for the technical team to solve technical issues.

Alongside data gathered from users across all case studies during this project, there will be additional ongoing feedback gathered through data and policy workshops held as part of the Cardiff Case Study. Whilst that feedback is yet to be generated and included in this report, it will, as will all feedback, inform future developments and support data needs of future Telraam users.

All of the above have greatly increased the sensor retention and a reduction of technical helpdesk tickets, yet more improvement is needed. In our assessment, the current sensor is not suited for large scale deployment, so a green-field, all-new design is likely needed (see further).

3.3.2 Sensor hardware

Apart from the software, there's been some experimentation with the hardware. While users have come up with a mix of solution to -for example- solve issues with a flexible camera-mount hinge, we want to highlight 2 participant-driven hardware developments: a 3D-printed camera mount and an outdoor enclosure

1. **Camera mount**: At least one user that we know of, has designed and built a custom-made Telraam camera-mount, solving problems with the flexible camera-hinge and making the anti-reflection sheet obsolete, greatly improving the user-experience.

Figure 20: User-designed 3D-printed camera-mount

This was a fully private initiative and the project team wasn't aware of this until we were contacted by the designer. We're currently investigating how to systematically replace the current camera hinge by this new design. All credits and technical files on the GitHub-page of the designer. https://github.com/KoenVdH/Telraam-camera-holder

2. **Outdoor enclosure**: Several users have independently developed a Telraam for outdoor use. In one example, a user whose house was too far from the street to have a Telraam installed indoor, instead opted to make a custom case for outdoor use:

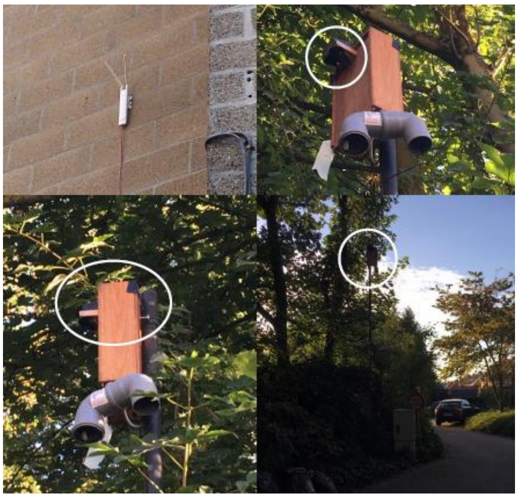

Figure 21: example of a user-built outdoor casing

The information was added to our FAQ: https://telraam.zendesk.com/hc/en-us/articles/360047121112-No-window-on-the-street-side-but-you-want-to-count-don-t-you-

A detailed second example from a Dublin-based user was recently developed and will be added to the FAQ as well. For completeness added as an annex to this report.

3.3.3 GitHub community

Due to the Covid19-restrictions, it was not possible to organize co-creation workshops. The co-creation has taken form mostly in gathering user feedback, helpdesk queries, project team feedback and isolated initiatives.

On the technical side, we did build and nurture a (small) "geek"-community on Github, leading to several contributions and future development idea's (e.g. compatibility with R Pi 4, Wifi-dongle,

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etc.). These users have also been important in implementing a few critical security measures early on in the project. The GitHub-page: https://github.com/Telraam/Telraam-RPi

3.3.4 Telraam v2

An important conclusion from the project, is that the current sensor is not user-friendly enough for large scale deployment, especially with non-technical users. Although the Telraam-sensor has improved during the project, not in the least due to active contribution by users, the technology is still too complicated for a large group of users.

Because of this, we launched the development of an all-new sensor, with an own hardware platform and custom casing. Development has started in February 2021 and is not expected to be completed before mid-2022. As such, the result will not be useable for the WeCount users.

However, we are involving WeCount users directly in the prioritization of the features to be included in the new sensor, by setting up an online "kampsite": https://telraam-sensor-v2.kampsite.co/

On this ad-hoc website, users can contribute their ideas, "upvote" highly desired features and comment on the proposals. We aim to involve some key WeCount participants as beta-testers for early prototypes.

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4 Conclusion

Both platform and sensor have been improved continuously during the project and will continue to evolve also after completion of this deliverable.

Most importantly, the platform was extended with some key features for user management and data extracts and supported with a new database structure, ready to scale.

The Telraam sensor was improved as well, mostly on the software side, but is still considered a bottleneck. We expect a completely new design will be needed to increase user friendliness sufficiently for scale-up to be successful.

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ANNEX – User-built protocol for outdoor use

Figure 22 Extension Lead Power Unit Housing

Figure 23 Micro USB Power Cable Power Unit Housing

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Figure 24 Power Unit Housing

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Figure 25 Telraam Sensor in Situ

Equipment List

1. Telraam Monitoring Sensor
2. Micro USB Cable (5m) and USB plug
3. Extension Lead (As long as necessary)
4. Wifi Extender (TP Link N300)
5. 5 Litre Water Bottle (Or equivalent weatherproof housing)
6. 3D Printed Housing Roof (Or equivalent housing)
7. 3D Printed Housing Main Body (Or equivalent housing)
8. A4 Clear Acetate (Plastic Covering for Housing Aperature)
9. Gaffer Tape
10. Double sided adhesive tape
11. Hacksaw
12. Scalpel/Scissors
13. Screwdriver
14. Measuring Tape

Preconditions

Measure distance, L, from nearest power supply to monitoring location. Use this distance to determine length of extension cord required.

Connect WiFi extender to relevant WiFi network.

Preferably execute in dry weather conditions.

Protocol

Telraam and WiFi Power Supply Unit

1. Using hacksaw, cut 5 Litre plastic bottle in half.
2. Pierce hole in the base of bottle with screwdriver.
3. Thread Micro USB cable through hole at base of bottle (widen with scissors if necessary).
4. Insert Micro USB cable into USB plug.
5. Unscrew and disassemble extension lead plug.
6. Thread extension lead cable out through the neck of the 5 Litre bottle such that the extension's sockets are in the half covered by the 5 Litre bottle.
7. Pierce hole in 5 Litre Bottle cap with screwdriver.
8. Thread extension lead wire through 5 litre bottle cap (widen cap hole if necessary).
9. Reassemble extension lead plug.
10. Plug in WiFi extender and USB plug into extension lead sockets.
11. Re attach bottle halves and seal with plenty of gaffer tape (see Figure 24).
12. Seal USB Cable hole and extension lead cable hole with gaffer tape to water proof.

Telraam Housing Unit

1. Cut Plastic Acetate sheet slightly wider than housing unit aperture.
2. Secure plastic acetate cover well with gaffer tape.
3. Place double sided adhesive tape underneath Telraam Sensor Unit.
4. Ensure Telraam Sensor Unit is positioned in housing unit such that the Micro USB port is facing the hole in the floor of the housing unit.
5. Remove other cover of double sided adhesive tape and secure Telraam Sensor Unit inside housing unit.
6. Connect Micro USB power cable into Telraam Sensor Unit.
7. Seal Micro USB cable hole with gaffer tape to weather proof and secure Micro USB cable position.

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8. Using double sided adhesive tape, secure Telraam Camera Sensor to Plastic Acetate covering on housing unit.
9. Use livefeed, when connected to Telraam WiFi network, to ensure appropriate camera sensor angle. Follow steps detailed in Telraam Guidance Manual to connect to Telraam WiFi Network.
10. Place roof on housing unit and secure well with gaffer tape.

Outdoor Telraam Sensor

1. Place Telraam Sensor in sheltered area if possible to provide protection from elements.
2. Wall height should be no more than 4metres above ground to account for Micro USB cable length.
3. Secure housing unit to location with gaffer tape, mounting components etc.
4. Ensure any wires are either covered or clearly identified to reduce trip hazards.
5. Periodically check Outdoor Sensor to ensure it remains well secured and upgrade water proofing with gaffer tape as appropriate.

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