TagItSmart!
Smart Tags driven service platform for enabling ecosystems of connected objects

Grant agreement 688061

Circular economy for electronics reuse

Deliverable ID:	**D 2.5**
Deliverable Title:	Process design (draft)
Revision #:	**v3.0**
Dissemination Level:	**Public**
Responsible beneficiary:	TagITSmart! Consortium
Contributing beneficiaries:	
Contractual date of delivery:	30.11.2018
Actual submission date:	03.12.2018

Start Date of the Project: 1 January 2016 Duration: 36 Months

PROPRIETARY RIGHTS STATEMENT
This document contains information, which is proprietary to the TagItSmart! Consortium. Neither this document nor the information contained herein shall be used, duplicated or communicated by any means to any third party, in whole or in parts, except with prior written consent of the TagItSmart! consortium.

Contents

Introduction ***4***

Section 1 - Explanation of the work carried out and overview of the progress ***4***

1.1 General improvements through TiS integration **4**

1.2 Definitions of processes **4**

1 Registration and refurbish 5

2 Retail and distribution 13

3 Pots-sale channel support 13

4 Recyclers 14

5 Device reuse management 14

Section 2 - Conclusions ***15***

Section 3 - References ***15***

PROPRIETARY RIGHTS STATEMENT

This document contains information, which is proprietary to the TagItSmart! Consortium. Neither this document nor the information contained herein shall be used, duplicated or communicated by any means to any third party, in whole or in parts, except with prior written consent of the TagItSmart! consortium.

Approvals

	Name	Organization	Date	Visa
Project Management Team	Leandro Navarro	Pangea	3/12/2018	L.N.

Document history

Revision	Date	Modification	Authors
v0.1	25/4/2018	First draft	Stephan Fortelny
v0.2	26/4/2018	Ready for revision	Stephan Fortelny
v0.3	28/4/2018	Consistency check and final reading	David Franquesa, Xavier Bustamante
v1.0	30/4/2018	First version of the deliverable	Stephan Fortelny
v1.1	28/6/2018	Update with new processes	Stephan Fortelny, Mireia Roura, David Franquesa, Xavier Bustamante
v1.2	6/7/2018	Ready for revision	Stephan Fortelny
v1.3	7/7/2018	Consistency check and final reading	David Franquesa, Xavier Bustamante
v2.0	8/7/2018	Second version of the deliverable	Stephan Fortelny
v2.1	30/10/2018	Update process.	Xavier Bustamante
v2.3	02/12/2018	Consistency check and final reading	David Franquesa
v3.0	03/12/2018	Third version of the deliverable	David, Leandro

Introduction

This document is based on deliverable D2.3 Process design (draft) and describes the processes for customer use cases (as described in D3.3) carried out with the support of eReuse tools and services.

Section 1 - Explanation of the work carried out and overview of the progress

The following processes describe in further details the steps to enable or facilitate customer use cases described in D3.3. The processes have been designed in close collaboration with the relevant customer segments.

1.1 General improvements through TiS integration

For each process, the expected improvements through TiS integration are summarized below the process description. Additionally, TiS integration is expected to improve most processes by the following means:

- Devices are currently identified by QR tags. Through TiS integration, tags feature both QR and NFC (as described in D2.1 System architecture and design).
- Through NFC, devices are scanned faster and more reliably especially in low-light conditions providing easier and more comfortable identification of devices.
- Maintaining QR codes as well serves as backup for devices not supporting NFC and may be easier in some use cases, e.g. for end-users due to higher-familiarity with QR codes.
- Easier and faster identification of devices facilitates splitting up preparation processes dynamically.
- eTags are globally unique and thus prevent registration of two devices with same identifier, further preventing errors in device traceability.
- eTags can not be copied or tempered with, increasing security and trust in the system.
- Speed and comfort of bulk processing of devices are increased dramatically in comparison to bulk processing with QR tags. As NFC tags do not require using the mobile phone's camera, bulk scanning of NFC tags can be done only by tapping the phone's NFC reader on devices sequentially and without having to interact with the mobile phone's screen.
- The eTag is photochromic which provides a quick way for the end-user to validate that the device has been refurbished correctly. The user can apply a challenge to ensure the veracity of the tag by illuminating it.

1.2 Definitions of processes

Definition of terms

- Android App, App: The eReuse.org Android App.
- Box: A server where the eReuse.org Workbench runs.
- User: a person or organization using the eReuse.org software, specially the Devicehub. For example a refurbisher or retailer.

- External user: a person that is not registered into the Devicehub of the user. For example a customer.
- Website, Devicehub: The eReuse.org Devicehub that the user works with.

1 Registration and refurbish

The purpose of the registration process is to link a physical device with a virtual device in the system. The new version of the system with the TiS has completely modified this process: Previously the users created the tags themselves and now this process is done by the users's devicehub provider. We keep the two ways of registering, one with simple QR tags created by refurbishers, and the other with eTags.

Improvements through TiS integration:

- eTags can not be copied or tempered with, increasing security and trust in the system
- Additionally to general improvements, easier and faster scanning and identification of devices allows to split up processes of registration and refurbishesment more dynamically.

1.1 Tag provisioning

Users can generate their own tags through Devicehub, printing them with a tag printer, or requesting eTags (the TiS tags) from an eTag provider.

To print their own tags:

1. The user goes to its Devicehub, selects the devices whose tags wants to generate and print, and presses *Print tags*.
2. The user specifies the size of the tag, the logo, and the fields that wants it printed on the tag.
3. The user presses *Print tags*, generating a PDF file with the tags.
4. The user opens the PDF file with its own PDF viewer and prints with it the tags.

The following section describes creation of eTags featuring NFC and QR on one single tag, going through the manufacturing of the tags and their distribution to the user. For this process we suppose we want 100 eTags.

Actors

- Tag provider: organization that orders and manages the eTags; it is certified by eReuse.org thus having permission to order the tags.
- NFC Tag manufacturer.
- Photochromic tag manufacturer.
- User: organization that uses the tags.

Requirements

At least one eReuse.org Devicehub. One Devicehub can contain several organizations and inventories, or organizations can have their own copy of Devicehub. Devicehub work distributely over the Internet.

One eReuse.org Tag running in a server over the Internet by the tag provider.

Process

1. The *tag provider* enters into the server containing the *eReuse.org Tag* software and executes the command `etag create-tags 100 --csv file.csv`, which creates 100 tags in the database and saves their URLs into a spreadsheet CSV file called *file.csv*.
2. The *tag provider* sends the CSV file to the *NFC tag manufacturer* and orders the 100 tags.
3. The *NFC tag manufacturer* creates those tags (NFC plus QR code) and updates the CSV file with the NFC ID of each tag, so each row of the CSV file contains the URL sent by the *tag provider* and the ID of the NFC tag created by the *NFC tag manufacturer*.
4. The *Tag provider* updates *eReuse.org Tag* with the ID of the NFC by executing `etag update-tags file.csv` where *file.csv* is the file sent by the *NFC tag manufacturer*.
5. The *Tag provider* orders 100 photochromic tags to the *Photochromic tag manufacturer*. Note that these tags don't require any special treatment.
6. The *Photochromic tag manufacturer* sends back 100 tags.
7. The *Tag provider* distributes the eTags (NFC and photochromic) to several organizations, *users*, both physically by sending them and virtually by executing `etag set-tags http://some-devicehub.com 0 100`; this marks the tags in *eReuse.org Tag* as *sent to some-devicehub.com* and creates the tags in that Devicehub.
8. The *user* receives the tags, sticks them in their devices, and scans the NFC or QR codes:
    1. By using the eReuse.org Android App the user can scan the QR code or the NFC of the eTag.
    2. If the *user* is processing devices with the eReuse.org Workbench, Workbench automatically attaches hardware information like serial numbers, otherwise the *user* can add that information through the app.
    3. These softwares communicate with the Devicehub of the user and command the Devicehub to link the device with the tag.
    4. The Devicehub of the user links the tag.
    5. The Devicehub creates or updates a virtual entity [1] in Everythng containing the device and the tag.
    6. If Devicehub or Everythng detect that the tag was linked they won't allow this operation. Devicehub can only detect if the app is linked by looking at its internal database. Everythng, as it contains all device and tag information, validates that the tag is not linked elsewhere.

1.2 Processing a device with Workbench

Processing a device with the eReuse.org Workbench means creating a hardware report of the device (including serial numbers and other metadata), linking the device with tags, and registering it to a Devicehub.

This is the first step when dealing with a new device with the eReuse.org tools, as it registers the device with the database, or updates its information if the device existed before. So any other process, unless stated contrary, requires this one to be performed to a device before.

For generic devices, the process is as follows:

1. The user opens the eReuse.org Android App (App) and selects *add snapshot*.
2. The user sticks and scans the tags of the device, including the `tags:eTags`, manufacturer tags (like serial numbers), and tags provided by third-parties like donors.
3. The user manually introduces other information, like ratings, finally submitting the information to Devicehub.

The process is as follows:

1. The user connects the computers to process to an eReuse.org Box running the Workbench Server software using a local network.
2. Computers boot and automatically execute the eReuse.org Workbench software, generating information from the computer and its components, erasing the data storage components, testing the machine, etc.
3. During the process, the user opens the Android App and selects the *Workbench* option, which connects the App to a running Workbench Server in the local network.
4. From now on, like in step 2. from the generic device, the user sticks and scans the tags from the device, specifically the `tags:eTags` and the ones provided by third-parties. The manufacturer tags are not required as such information is taken by the Workbench automatically.
5. Android App and Workbench embed the information into a report that is submitted to Devicehub.

1.3 Tagging

This section describes how to tag devices, linking the tag and the information of the device.

Process

1. The user sticks the tags on their devices, and scans the NFC or QR codes:
2. By using the eReuse.org Android App the user can scan the QR code or the NFC of the eTag.
3. If the user is processing devices with the eReuse.org Workbench, Workbench automatically attaches hardware information like serial numbers.
4. Additionally, the user can add more information about the device by fulfilling a form that appears in the App after scanning the tag.
5. When the user submits the form, it triggers both softwares (the App and the Workbench) to communicate with the Devicehub of the user and command the Devicehub to link the device with the tag.
6. The Devicehub of the user links the tag.
7. The Devicehub creates or updates a virtual entity [1] in Everythng containing the device and the tag.
8. If Devicehub or Everythng detect that the tag was linked they won't allow this operation. Devicehub can only detect if the app is linked by looking at its internal database. Everythng, as it contains all device and tag information, validates that the tag is not linked elsewhere.

1.4 Rating

Rating a device is the act of grading the appearance, performance, and functionality of a device. This results in a `Rate` action, which includes a guessed **price** for the device.

There are two ways of rating a device:

1. When processing a computer with Workbench and the Android App.
    1. While Workbench is processing the machine, the user links the tag with the computer. In this process, as it requires the user to scan the tag with the App, the app allows the user to introduce more information, including the appearance and functionality.
    2. The App embeds the rate with the device report generated by the Workbench.
    3. The Workbench uploads the report to Devicehub.
2. Anytime with the Android App or website.

- The user scans the tag of the device with the Android App. After scanning it, the App allows the user to rate the appearance and functionality.
- Through the website, the user searches the device and then selects to perform a new `ManualRate`, rating the appearance and functionality.

In any case, when Devicehub receives the ratings, it computes a final global `Rate`, embedding a guessed price for the device.

1.5 Preparing a device for reuse

Users, like refurbishers, ready the devices so they are suitable for trading. This process implies repairing, cleaning, etc.

1. The user scans the tag of the device with the Android App or searches it from the website and selects *actions* > `ToPrepare`, which informs Devicehub that a device has to be prepared for trading.
2. The user prepares the device. Upon success, it performs the action `Prepare` in the similar way that did in 1.
3. A prepared device might still not be ready for trading. For example, a seller still might want to clean a device once a trade has been confirmed, for example because the device gathered dust between the preparation and trading. To denote a final "this device is ready to be used or shipped", the user performs the action `ReadyToUse` in the same way it did in 1.

If the device is broken or it breaks, the user performs the action `ToRepair` denoting that the device has to be repaired, and `Repair` upon success.

Broken devices that are not going to be fixed are set to 1.18 Dispose a device.

1.6 Track a device

1.2 Processing a device with Workbench registers into Devicehub the required metadata from a device to identify it: a digital passport for the device (information submitted in a Devicehub), plus a physical passport (a tag that links the device with the digital passport). If the physical passport is an `tags:eTags` then it is unforgeable.

The rest of the traceability is based in keeping track of the events occurring on the device, for example when it changes location or it is traded. eReuse.org allows recording these actions, providing mechanisms to ease them or ensure them. Please refer to the specific use cases for more information.

1.7 Share device information

Users can generate public links to share with external users, like retailers or donors, so they can see a subset of the metadata. Thanks to this, external users can audit the devices (donors, consumers), take confident and faster decisions when requesting devices (retailers, consumers).

This information includes hardware information, device rates, device price (both guessed and manually set), and a public part of the traceability log.

To share devices:

1. The user scan the tags of the devices it wants to share with the Android App or searches the devices through the website.

2. The user select *generate sharing links*, which gives it a list of public links of the devices.
3. Users send those links to their contacts using their preferred method, like e-mail.
4. External users visit those links in order to see a web page containing the public information of the device.

Public information of a device is always accessible when an user scans the QR of the tag through its smartphone, as the QR contains a public link of the device. This way people in physical contact with the device, like consumers, can always check information about the device.

The public webpage

The public webpage of a device includes:

- A description of the device, including specifications, public identifiers, and associated tags.
- Instructions in how to challenge the Photochromic tag of the device for 1.8 Checking device authenticity.
- Traceability log of the device.
- The public custody chain for present devices (5.2 View public custody chain for present devices).
- Certificates like erasures.

1.8 Checking device authenticity

Any user can check the authenticity of a device registered in a Devicehub, even if the user is not registered, like a customer.

If the device has an `tags:eTags` or a regular tag generated by a Devicehub (stuck on the 1.2 Processing a device with Workbench), the process is as follows:

1. The user scans the QR code with a smartphone using a generic QR code scanner.
2. The scanner opens the browser and takes the user to (The public webpage) containing public information of the device, like identifiers and instructions in how to challenge the photochromic tag.
3. The user tests the photochromic tag by touching the flash bulb of the smartphone with the tag for, at least, 6 seconds, checking that the tag changes color temporarily.

Other ways of checking device authenticity are:

- Scanning the QR code stuck and comparing the serial numbers of the device with the ones of the public webpage.
- Directly applying the photochromic challenge.

Workbench and Devicehub detect changes in computer components. Certain scenarios where the computer passed by untrusted users require ensuring that no component has been taken or replaced. A deeper verification process is re-processing the computer with Workbench, generating a new report that updates the information of the computer in the Devicehub, ultimately showing the differences in removed and added components.

Finally, the eReuse.org team is developing, using the platform [1] Evrythng, a global record of devices, which takes non-private IDs of the devices of participating Devicehubs and records the most important life events of the devices. This database is publicly available, so users can search on it an ID of a device, for example the S/N or the one written in a tag, like an `tags:eTags`, and know which Devicehub is registered in, ultimately accessing the public information of the device.

1.9 Recover a lost device

Users can recover a lost device found in a waste dump by following the process of 1.8 Checking device authenticity.

A Devicehub participating in the global record of devices automatically uploads public device information into Evrythng [1]. If the device was previously registered in another Devicehub and there is no record of trading between Devicehubs, Evrythng [1] warns both systems. Note that this functionality is in development.

1.10 Rating a device

Rating a device is the act of grading the appearance, performance, and functionality of a device. This results in a `Rate` action, which includes a guessed **price** for the device.

There are two ways of rating a device:

3. When processing a computer with Workbench and the Android App.
    1. While Workbench is processing the machine, the user links the tag with the computer. In this process, as it requires the user to scan the tag with the App, the app allows the user to introduce more information, including the appearance and functionality.
    2. The App embeds the rate with the device report generated by the Workbench.
    3. The Workbench uploads the report to Devicehub.
4. Anytime with the Android App or website.
    - The user scans the tag of the device with the Android App. After scanning it, the App allows the user to rate the appearance and functionality.
    - Through the website, the user searches the device and then selects to perform a new `ManualRate`, rating the appearance and functionality.

In any case, when Devicehub receives the ratings, it computes a final global `Rate`, embedding a guessed price for the device.

1.11 Storing devices

Devices are stored in places like warehouses.

`Locate`, `Receive`, and `Live`, actions help locating devices, from a global scale to inside places.

The `Locate`, `Receive`, and `Live` embed approximated city or province level information, and the user can write a location, name, or address in Locate and Receive. This location can be as detailed as required, like shelves in a building. Users can create actions by scanning a tag with the App or searching a device through the website, and then selecting *create an action*.

Lots are more versatile than actions, and they do not pollute the traceability log, which is unneeded when placing devices in temporal places like warehouses. Lots act like folders in an Operative System, so the user is free to choose what each lot represents —for example physical locations:

- Lot company ACME
    - Lot Warehouse 1 of ACME
        - Lot Zone A
            - Computer 1

- Monitor 2

To create a lot the user uses the webiste or App, selecting *create lot* and giving it a name.

To place devices inside a lot through the website, the user selects the devices, it presses *add to lot*, and writes the name of the lot. To place them through the App, the user scans the tags of the devices, it presses *add to lot*, and writes the name of the lot.

To look for devices the user reduces the area to look for them by checking to which lot the device is. This is done through the website or App by searching the device and checking to which lots is inside, or searching the lot and checking which devices are inside. Once the user is in the place, it picks up the correct device by reading its tag.

1.12 Erasing data and obtaining a certificate

When (1.2 Processing a device with Workbench) the user can order Workbench to erase the data stroage units. In the configuration users parametrize the erasure to follow their desired erasure standard (involving customizing erasure steps).

Once the Workbench uploads the report to a Devicehub, the user gets the erasure certificate of the (data storage units of the) computer.

A logged-in user with access to the device can scan the tag with the App or search the device through the web app and select *certificates*, then *erasure certificate*, to view an on-line version of the certificate and download a PDF.

An external user can access The public webpage of the device to download the erasure certificate.

1.13 Delivery

`Receive` is the act of physically taking delivery of a device. When an user performs a Receive, it means that another user took the device physically, confirming reception.

To perform this action the user scans the tag of the devices with the App, or search it through the website, and selects *actions* > *Receive*, filling information about the receiver and delivery.

An exemplifying case is delivering a device from the warehouse to a customer through a transporter:

1. Warehouse employees look in the website devices that are sold, donated, rented (`Trade`) that are still in the warehouse and ready to be used.
2. They store the devices in the warehouse (1.11 Storing devices).
3. Once the devices are located the employees give them to the transporter. To acknowledge this to the system, they scan the tags of those devices with the App and perform the action `Receive`, stating that the transporter received the devices.
4. The transporter takes the devices to the customer, performing the same `Receive` again, this time stating that the customer received the devices.

The last `Receive` of a delivery, the one referring to the final customer, can activate the warranty (3.2 Provide hardware warranty).

1.14 Value (price) devices

Devicehub guesses automatically a price after each new rate, explained in 1.10 Rating a device, and manually by performing the action `Price`. By doing manually it, the user can set any price.

To perform a manual price the user scans the tags of the devices with the App, or searches them through the website, and selects *actions* > *price*.

The user has still a chance to set the final trading price when performing `Trade`. If the user does not set any price, and the trade is not a `Donation` or similar, Devicehub assumes that the last known price is the one which the device is sold.

1.15 Manage sale with buyer (reserve, outgoing lots, sell, receive)

We exemplify the use of lots and actions to manage sales with a buyer.

1. The first step on sales is for a seller to showcase the devices to potential customers by sharing them (1.7 Share device information).
2. A customer inquires about the devices, for example through e-mail.
3. This can imply a reservation process. In such case, the seller can perform the action `Reserve`, which reserves the selected devices for the customer. To perform that action, the user scan the tags of the devices with the App or search them through the website, select them, and click *actions* > *Reserve*.
4. Reservations can be cancelled but not modified nor deleted. To cancel a reservation the user uses the App or the web to select the devices, and look for their reservation to cancel it.
5. A reservation is fulfilled once the customer buys, gets through, or rents a device; for example by an e-commerce or through a confirmation e-mail. To perform any of those actions in Devicehub, a seller selects the devices and clicks *actions* > *Sell*, *Donate*, or *Rent*. It can perform those actions over devices that are not reserved, or mix reserved devices with non-reserved devices. Refer to `Trade`.
6. Lots help sellers in keeping an order in sales. A good ordering is creating a lot called `Sales`, and then, inside that lot, a lot for each sales, and/or a lot for each customer.
7. The seller gets confirmation from the warehouse or refurbisher that the devices have been prepared for reuse (1.5 Preparing a device for reuse).
8. Devices are delivered (1.13 Delivery) to the customer.

1.16 Verify refurbishment of a device through the tag

Devicehub and eReuse.org allows usage of the `tags:Photochromic tags` to visually assist users, at-a-glance, in verifying correctly non-fraudulent refurbishing of a device.

Users like refurbishers stick the tags on the devices.

On the end-user side:

1. The end-user wants to verify refurbishment from a device of a retailer.
2. The End-user sees a QR in a tag, like the the `tags:eTags`, which scans with its smartphone's QR reader app, taking the user to the 1.7 Share device information,
3. The public web page contains, along information about the device, instructions on how to check the validity of the Photochromic tag — consisting on illuminating the tag with the smartphone's lantern during a minimum of 6 seconds.

1.17 Delivery or pickup from buyer after use

After customer usage devices can be picked-up so they are prepared for re-use or recycle.

Once the customer agrees for the devices to be taken, a transporter or the same customer takes the device to the warehouse, and an employee performs a `Receive` to state that a

device has been physically received, and a `Trade` to state the change of property. These actions can be performed by scanning the tag with the App or by manually searching the device through the website.

1.18 Dispose a device

Users can manage the disposal of devices in Devicehub. A disposal in Devicehub means two things: 1) trading devices to a company that manages its 2) final destruction or recovery.

The first case is managed by the actions `ToDisposeProduct, DisposeProduct`:

1. An user marks a device to be disposed by scanning the tag of the device or searching it through the website and selecting *actions* > *ToDisposeProduct*.
2. When the organization in charge of the disposition takes the device the user performs *actions* > *DisposeProduct*.

The latter case is managed by the actions `DisposeWaste, Recover`. The user performs the action *DisposeWaste* when the product has been destroyed and put into waste, and *Recover* when the product has been recycled.

2 Retail and distribution

2.1 Make devices available for sale to final users

Once the devices are registered in the Devicehub, users can share the devices to potential customers. Please refer to 1.7 Share device information.

2.2 Manage purchase of devices with refurbisher / ITAD

Please refer to 1.15 Manage sale with buyer (reserve, outgoing lots, sell, receive).

2.3 Distribution of devices

Please refer to 1.13 Delivery.

2.4 Transport between service providers and buyers

Please refer to 1.13 Delivery.

2.5 Estimate selling price

Please refer to 1.14 Value (price) devices.

2.6

3 Pots-sale channel support

3.1 Customer service for hardware issues

Devicehub allows introducing contact information in the The public webpage of the device, including an e-mail and phone number.

This information is based on the default organization, which an administrator sets when installing Devicehub.

3.2 Provide hardware warranty

Devicehub helps in recording the day the warranty is activated by saving in the traceability log the delivery of the device to the final user. Specifically, an user can check the last `Receive` (step 4. of 1.13 Delivery) to be the one that activates the warranty.

4 Recyclers

4.1 Get the certification for recycling

Recyclers can obtain a certificate after performing the process of 1.18 Dispose a device.

To obtain the certificate, the user scans the tags of the devices with the Android App or searches them through the web, and then selects *certificate* > *recycling*.

5 Device reuse management

5.1 Get internal custody chain report for donations

Users can obtain the internal custody chain report for donation as an comma separated value spreadsheet.

To obtain the document, the user scans the tags of the devices with the Android App or searches them through the web, and then selects *certificate* > *Internal custody chain report for donation*.

Users can see part of this information too by selecting *Actions* after selecting a device, resulting in a web view of the traceability log of the device.

5.2 View public custody chain for present devices

The public custody chain of a device is part of the public information of the device that users can share as part of the process of 1.7 Share device information.

Section 2 - Conclusions

TiS integration improve eReuse main processes and subsequently facilitate relevant use cases of different customer segments. Through the use of NFC-enabled tags, processes of handling devices such as registration, refurbishment and transport are faster and more seamless due to improved scanning of devices. Additionally, this also enable to split up some processes dynamically so they can be executed asynchronously. Furthermore, adapting and integrating eReuse key modules to TiS ihas improved functionality and user experience of the respective modules.

Section 3 - References

[1] D1.2 Initial TagItSmart! Reference Architecture and API description [Online]. Available: https://www.tagitsmart.eu/D1.2.pdf