GALIST
Galileo Smart Traceability
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EXECUTIVE SUMMARY REPORT

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VERSION HISTORY

Version	Date	Reason for change
1.0	15/06/2018	First issue
1.1	27/06/2018	Updated according to ESA comments

CHANGE LOG

Version	Section	Reason for Change
1.1	1	Added, in the first page, the description of the product and service
1.1	3	Added information about the current use of the APP
1.1	various	Spell/syntax check, renumbering of figures

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1 INTRODUCTION AND BUSINESS ASPECTS

GALIST is a project that supports the traceability of food products linked to their position and the occurrence of significant events (e.g. labelling, packaging, shipping). The system is based on an innovative concept of utilisation of the GNSS combined with ADSB data, which is provided by airplanes.

The GALIST project uses, in fact, a double-certification approach – based on a proprietary algorithm – to keep track of the products. Each product is marked with a specific ORIGOSAT tag, a QR code, which allows consumers to access the certified information – thus reaching the full awareness of the "Made-in" value. Clearly, the position's certification is a key enabler of the service.

The following figure describes, at very high level, the major operational scenarios of the system – the last being activated by the consumers thanks to an App installed on their smartphone:

- Firstly, the system regularly computes and validates the position of the GNSS and ADS-B receivers through the processing of data collected on site, combined with auxiliary data from reference sources. This is a background task performed every minute or couple of minutes;
- Secondly, when a specific event has to be recorded, the tag on that product is read asynchronously, and the local PC sends a certification request to the service centre. The result of the certification request is stored in the database and sent back to the requester;
- The last major operational scenario is related to the tag reading process: as soon as a consumer reads the tag via the dedicated App, the system returns all the relevant information and the certification status.

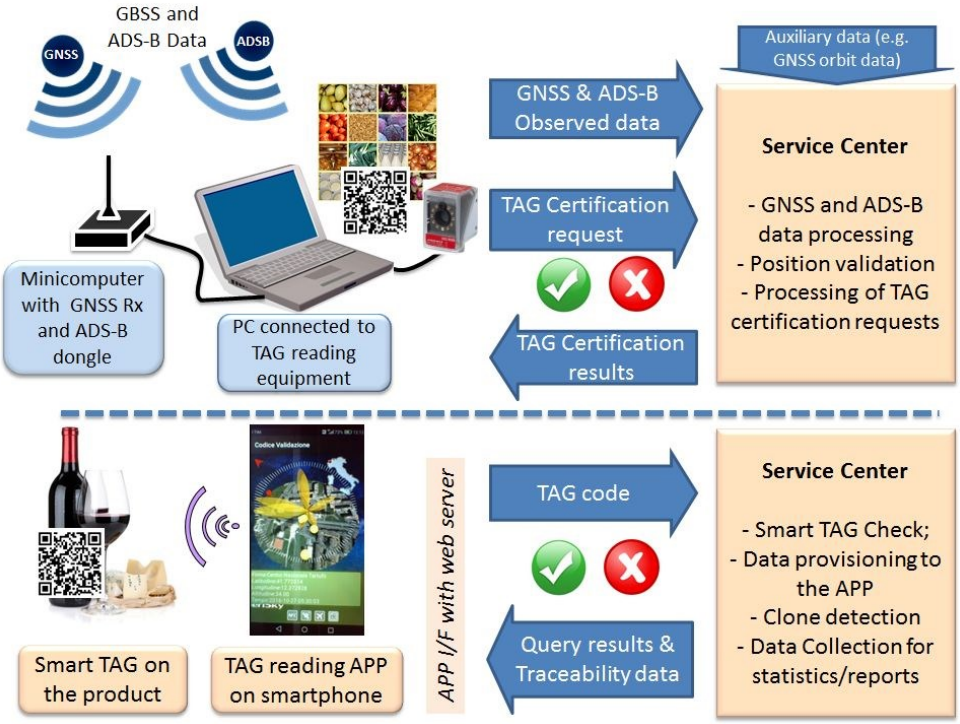

Figure 1: GALIST concept

GALIST aims to open new business opportunities in the traceability market, and prove to be an added value to existing solutions and products. The core innovation is based on the validation of radio-localisation data and its integration with other emerging technologies. The project's goal is to get the best out of the following three contributions:

1. Validated GNSS data: dedicated GNSS and ADS-B algorithms as the core function;
2. Smart labelling: QR codes for low cost integration on production chains;
3. Applications on Smartphones: for easy, quick and zero cost access to traceability data.

The GALIST service complements the existing models of IGP/DOP with traceability and marketing instruments for all cases in which the IGP/DOP model is not applicable, feasible, and/or compatible with that type of business. The system could even provide additional technological certification for IGP/DOP products.

The GALIST project allowed for the building and testing of a proof of concept for the technical and economic needs, as well as an analysis of the roadmap towards a commercial exploitation of the concept.

By using a smartphone App, consumers will be able to directly verify the origin of the product, access additional information relevant to the product and its territory of origin, and eventually get in touch with the producers.

The idea is to develop a *Certification of Origin* Platform, which, on the one side, provides a more simple and modern tool to guarantee the origin of the product, and, on the other side, presents the producer with a powerful marketing tool aimed at improving their retained value across the agri-food value chain.

Therefore, we can define a "*tag line*" as follows:

"Origosat is a cheap and powerful Platform for the Certification of Origin of products that will enable producers to guarantee the origin of their products directly to the consumers, while giving them the opportunity to get in contact with each other"

Indeed, the system is merging a Certification of Origin with a Marketing Platform.

With respect to a plain marketing platform, the distinctive element here is the capability of certifying the origin of the product through a trusted platform and specific Origosat algorithms.

Therefore, the market Origosat is aiming at is the provision of certificates *guaranteeing the origin of products*, and related certification services – the competitors are the traditional (old-fashioned) certification providers.

To this end, the smart labelling tag becomes truly a "gate" for the consumer to access information and details about the product.

The producer could, in turn, use such smart labels as a unique opportunity to open this "gate" and prove to consumers his willingness to be transparent, as well as using the quality behind the product as a promotion. The smart labels could help consumers save

time when obtaining information, avoiding reading long texts (which often appear in small fonts due to size limitation of traditional labels) and cryptic information, which is comprehensible only to specialists.

The smart label is indeed a quick and easy way to transfer information with flexible and scalable detail. This approach is in line with the consumers' interest and hopefully with their willingness to get deeper knowledge of the products.

The smart label "gate" is also a unique opportunity for producers to get feedback from consumers when they access traceability data. Specific mechanism of marketing can be also implemented thanks to the "bridge" between the producer and the final consumer.

Many of the small and medium enterprises in the food sector are still using business models and marketing techniques focused on patterns established during the last century. As a result, that competition is often squeezed on prices even for products which could aim at the richer Gourmet niche.

Certification of origin is a widely used tool to get out of the bunch. In Europe, this approach is based on consolidated process certification and is enforced by the law through DOP/IGT certifications. The pursued business idea changes the paradigm and opens a wider competitive space with respect to current certification methods.

The following *competitive factors* are affecting the *value* delivered to customers:

- **Cost of certification**: the cost sustained by the companies in terms of impact on production processes when subject to the constraints posed by specific certifications. The DOP/IGP certifications are regulated by the EU legislation. The cost of implementing all the constraints and ensuring the correct administrative processes is high. In fact, many producers decide not to apply it for that reason alone;
- **Bureaucratic overhead**: Every certification based on process verification imposes a certain overhead in terms of bureaucracy, which affects the focus on core business;
- **Constraints to the production**: the various constraints that certification regulations require to provide certificates. Constraints mean everything related to the product specification document. This document is defined and enforced by the law at the time of registration constitution at the EU offices. These constraints limit the single manufacturer's ability to differentiate his product from the competition. In fact, it is the same for each and every product of a certain family;
- **Positive effect on Marketing**: Easier placement on the market is the potential added value to the single product. This is achieved thanks to the certificate of origin, which increases the product's attractiveness on the market. This parameter also includes the ability to differentiate the certification w.r.t. competitors;
- **Value retention along value chain**: marketing power with respect to other actors across the value chain. For example, in foreign markets, large distribution networks retain a large chunk of the value due to their proximity to the end customers;
- **Local Marketing**: capability of supporting collective local brands, such as regional brands and umbrella brands;
- **Product Geo-localisation (Technological Innovation)**: the ability to geo-localise product origin using GNSS technology.

There are two major differences between the Origosat service and the DOP/DOC certification:

1. Reduction of the total cost and complexity, including bureaucratic burdens;
2. Capability of shortcutting the connection with the consumer, also in foreign markets.

Furthermore, the benchmark is set against two additional certification methods that are widely used in the agri-food sector:
- EU DOP/IGT Certification;
- Standard Custom Process Certifications based on Product Specification.

But the substantial detachment between traditional tools and Origosat is really the reduction of the total costs, including burdens related to a process-based certification. Moreover, Origosat will provide, with the App, an additional tool for the producer to establish contact with the end-user: an opportunity that traditional certifications do not support.

Finally, two major factors are considered in terms of weights for a synthetic comparison:
- The positive effect on marketing – and the capability of creating value for the producers;
- The evaluation of the constraints on the production process introduced by a certain certification approach.

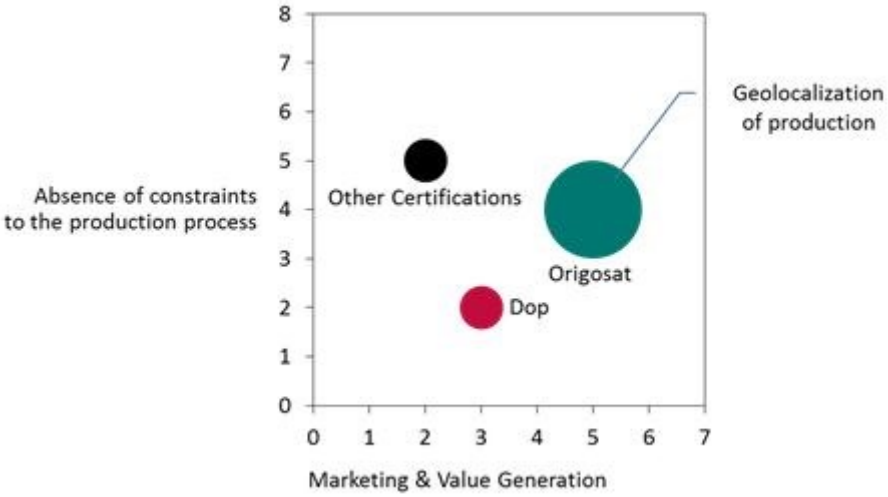

Figure 2: Two-factor comparison of the certification processes

In conclusion, the Origosat approach aims at providing larger values with tolerable downsides to the production process.

2 THE GALIST SYSTEM

The system has been designed by means of deep interaction with the producers involved in the proof of concept: the "*Centro Nazionale Studi Tartufo*" in Alba, for their internationally known white truffles, and "*I Tesori della Terra*", a producer of biological yogurt in Cervasca (Cuneo).

The GALIST project implements a double-certification approach based on a proprietary algorithm, which makes use of GNSS and ADS-B data to locate significant information associated to a production event.

Clearly, the position's certification is a key enabler of the service.

The GNSS complementation with ADS-B data allows for redundancy, and, to some extent, even GNSS spoofing countermeasures. In fact, the system implements a configurable validation schema and, according to the selected schema for a particular installation, the ADS-B can support detection and, in part, mitigation of GNSS spoofing attempts.

The prototype supports both **manual labelling** (operator-based) and **automatic labelling** (machine-based) certifications. For the latter case, performance tests have been executed to demonstrate the capability, even of the prototype, to fully support the throughput of industrial automatic labelling machines. The GALIST service architecture is described in the following diagram:

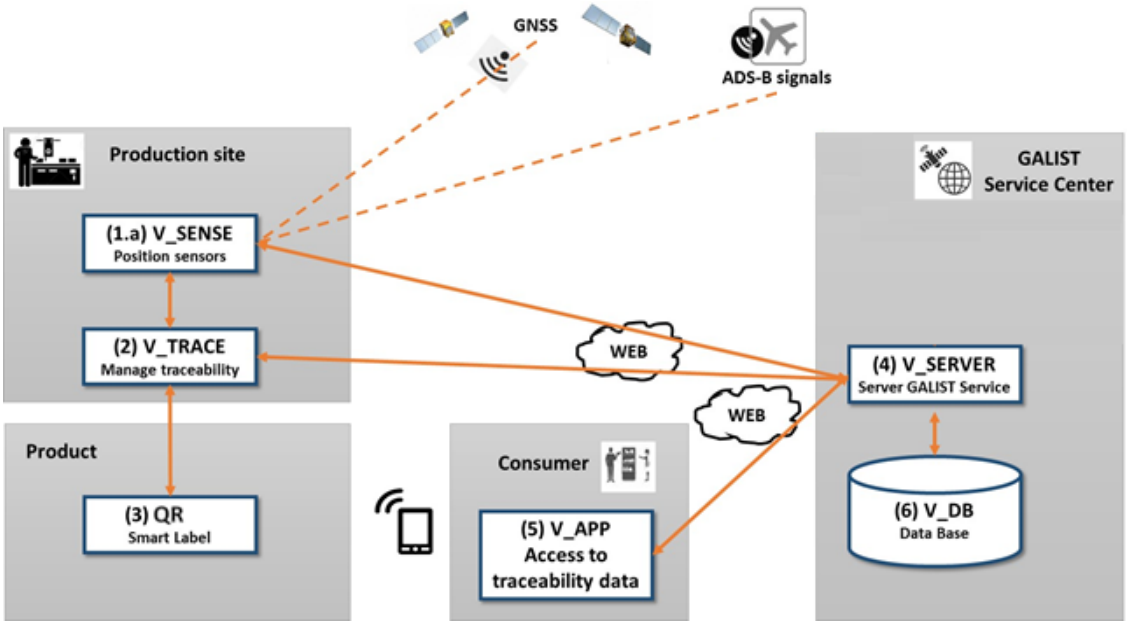

Figure 3: Overall GALIST service architecture

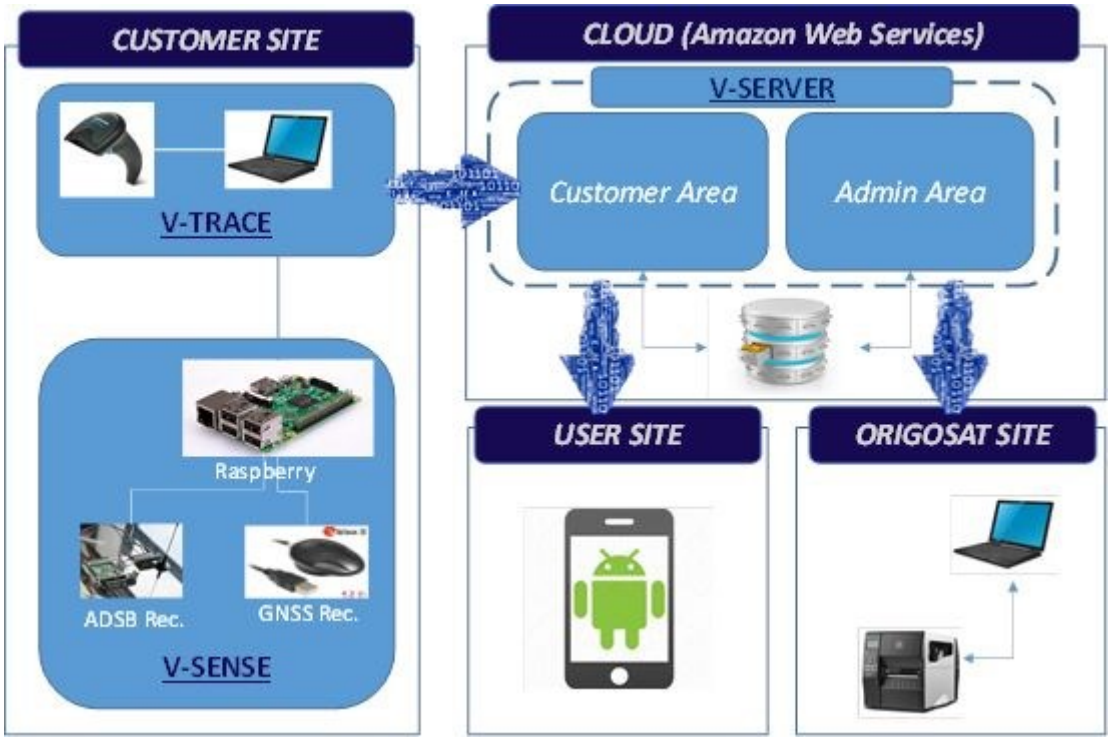

Figure 4: High level architecture of the prototype

The feedbacks collected during proof of concept campaigns have been used to consolidate the functionalities to be implemented, and to improve the prototype in line with users' experience with the system.

The architectural components of the GALIST system are the following:

- **V-SENSE**
  - The «sensing» element of the system, equipped with GNSS receiver and ADS-B receiver. Its main role is to provide the measurements;
- **V-SERVER**
  - The central node of the system, granting access to all users and managing the centralised database. It performs the validation of the signature and provides information to the consumer;
- **V-DB**
  - Relational database used to manage all the information;
- **V-TRACE**
  - The SW installed at customer site. It allows the operator to perform all the needed local functions, including request of signature certification;
  - It manages the QR scan equipment (manual | automatic);
- **The App**
  - The smartphone application used by the consumer to get – through the V-SERVER – added value information, which is stored in V-DB;
  - The **App** for smartphones is available for installation in the PlayStore of Google.
  - Even other QR readers (e.g. the App "BAR CODE scanner") can be used to access the certification service (Android and IoS). However, in this case the returned information and the user experience are both limited.

Figure 5: GALIST operations in CNST (Alba, above) and "I Tesori della Terra" (below)

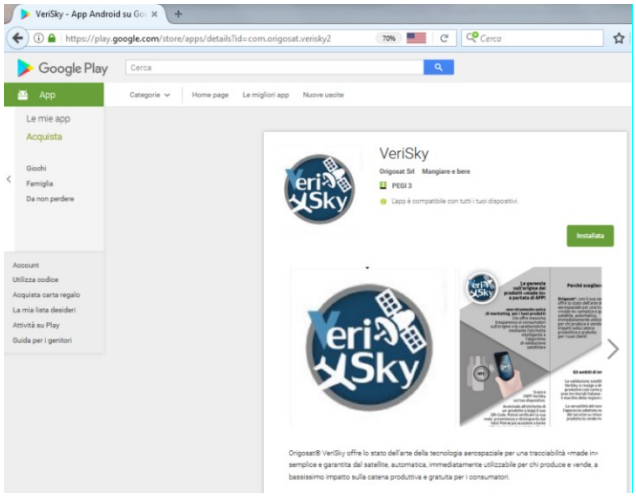

Figure 6: The App in Google Play Store

The V-SENSE is composed by the following items:

- Raspberry PI 3 (OS Raspbian Linux v4.4.21-v7+)
- GNSS Received Model: Multi GNSS u-blox 8 NL-8012U; main Characteristics
  - Multi constellation receiver (GPS, GALIEO, GLONASS)
  - Frequency:
    - GPS: L1, 1575.4200 MHz
    - GALILEO: E1, 1575.4200 MHz
    - GLONASS: L1, 1602 (k x 0,5625) MHz
    - BEIDOU COMPASS: B1, 1561.0980 MHz
    - QZSS: L1, 1575.4200 MHz
  - Supports NMEA 0183 protocols: GGA, GSA, GSV, RMC, VTG
- ADS-B Receiver, model NooElec NESDR SMArt - Premium RTL-SDR (RTL2832U /R820T2)

Figure 7: The V-SENSE HW

Two different kinds of **QR code scanners** are used to scan the QR codes, according to the use case: Manual certification use case and Automatic certification use case.

It is important to note that the SW applications (V-TRACE, V-SERVER) are able to handle both use cases. Therefore the two use cases are managed using the same configuration except for the scanner.

- Handheld scanner for manual certification:
Model USB Datalogic Quickscan QD2430

- High TRL: suitable for real production environment
- Used for manual certification of Origosat QRCode tags

- Omnidirectional Scanner for automatic certification
Model USB Datalogic Magellan 800i

- Entry Level Industrial scanner: suitable for an industrial PoC
- Used for automatic certification of Origosat QRCode

- Thermal printer for Origosat QRCode tags
Model: Zebra ZT230, USB and Ethernet connectivity

- Low/medium technology readiness level
- Used to print Origosat Qrcode tags

2.1 Certification Scenarios

The underlying concept of the system is the capability of the VTRACE to transmit a certification request to the VSERVER, which, on the basis of various algorithms, decides to provide or deny the requested certification.

The following certification scenarios are identified in the system:

- ***Manual certification*** scenarios:
  - Single QR certification (e.g. the one applied at CNST for the truffles' certification). This scenario allows for the insertion of extra attributes – if requested by the producer during service agreement – such as the information for the specific product;
  - Bulk Roll certification for a roll composed by a set of identical QR labels: by certifying one of the QR, the full set of QRs in that roll is certified;
  - Roll composed by a set of different QRs: by certifying one of the QR, the full set of QRs in that roll is certified.

  The last two scenarios are useful for an easier integration with automatic labelling machines, where the QR roll is certified prior to insertion in the labelling machine. The future integration of QR readers with the labelling machines will allow a fully automatic certification approach. This complex integration scenario is already supported by the SW prototype.

- ***Automatic certification***: it is the implementation adopted for the integration with automatic labelling machines. The local operator opens a certification session and closes it when the automatic labelling activity is completed. This kind of certification is conceived for future integration with automatic labelling machines. When the certification process needs to be started, the operator opens a session and enables an automatic labelling machine to send certification request at high frequency, according to its throughput. The system responds to each request while the session remains open. When the operational activity is done, the operator closes the certification session.

Clearly the background principle is the same for all certification scenarios described above: when a certification request is transmitted by VTRACE, a ***Global Validation Status*** is accessed. The certification is granted only if the Global Validation Status is *"OK"*.

In addition, in order to override potential operational issues in daily operations, including week-ends, nights, etc., and granting a high level of service availability, a workaround operational process has been implemented: the ***Manual self-certification***. It represents a self-declaration from the producer that the activity has been performed within the certification area. This function bypasses the VSENSE and the VTRACE, and is provided via direct access to specific VSERVER services.

The goal is to support the production operations also in case of crashes or failures of the VTRACE and/or the VSENSE. The self-certification events are logged for further investigation, in order to limit the use of this function only to critical situations – so far, it has never been applied during the 6 months of operations on "CNST" and "I Tesori della Terra", the two production sites where the system is up and running.

The V-DB stores all the information relevant to the product and makes it available to the consumer, and additionally offers an easy way to make the label really "smart". In such a

way, the labelling expands its capacity to the handling of text, picture, style, logos, photos and designs.

Figure 8: The products with the attached QR tags

This service approach provides a strong protection against possible frauds: if a fake QR tag is produced, the system detects it as fake. This capability increases the trustability of the product offered to the consumer.

For instance, thanks to its design, it is practically impossible to produce fake information: the ORIGOSAT QRCODE contains the identification code of the product to which it is associated. Furthermore, the valuable information is stored in a secure DB managed by the VSERVER SW application.

Finally, the DB has been designed to handle several types of events (e.g. collection, entry in the storage warehouse, exit from the warehouse, etc.), even though the prototyped application has been focused on the labelling event.

2.2 Certification Logic

The GALIST System constantly monitors the following information:

- The position of the VSENSE – to guarantee the geo-localised certification of events;
- The hardware and software health of the VSENSE devices – to ensure that the connection status and the devices providing certification information are operative.

To achieve this, each VSENSE periodically sends the following data to the VSERVER:

- a timestamped GNSS/ADSB *signature* dataset;
- a device status record.

The *signature* is a data set including: the timestamp, GNSS data, ADSB data, validity status, and other info. A signature is associated to an event (e.g. "Labelling" of a specific product) and linked to the relevant QR.

The signatures and the device status records are sent according to a configurable schedule configured in the VSENSE.

At the time of service setup, an Origosat operator configures the VSENSE "***certification area***", represented by one or more circles, each defined by latitude/longitude coordinates and tolerance radiuses for GNSS & ADSB validation.

The system aims at guaranteeing that the receiver is within the certification area configured for the specific Customer (e.g. a small "spot" located at CNST in Alba).

The service is provided according to a "Validation schema", which is configurable for each Customer, and is based on a set of simple statuses.

The following statuses are in fact associated to the VSENSE, and combined with each other to compute the "Global Validation" according to the configured validation schema:

- GNSS Device Status (checks the HW/Connection status of the device);
- GNSS Position Status (checks if the position is within the certification area);
- GNSS Validation Status (result of the GNSS spoofing detection algorithm);
- ADSB Device Status (checks the HW/Connection status of the device);
- ADSB Position Status (checks if the position is within the certification area).

The VSERVER, depending on the validation schema that was configured, uses a specific combination of the above statuses to calculate the ***Global Certification Status***.

If the Global Certification Status is *"OK"*, the system allows the QR Code tags certification, and associates the last valid signature to the tag event for which the certification was requested. If, on the contrary, the Global Certification Status is not *"OK"*, the system denies QR Code tags certification and invalidates the tag – the system's evaluation is that the VSENSE is either outside the certification area (i.e. it has been moved away from the agreed certification area), or the VSENSE is out of range, or out of order.

In order to mitigate the effect of possible prolonged network unavailability or VSENSE failure, a manual self-certification feature is provided to the Customer to allow for seamless operations even in case of failures. Naturally, the events are recorded and statistics are collected in terms of automatic-/self- certifications performed.

3 PROOF OF CONCEPT

A large set of tests has been performed in factory and on site for both selected producers (CNST and *"I Tesori della Terra"*) for over 6 months of operations.

The GALIST prototype has been configured and integrated with local environment, and is currently supporting the operational use of the two producers.

Figurer 9: The Yogurt produced by "I Tesori della Terra", with the QR codes certifying the "Made-in"

The GALIST System has been utilised to certify more than 1000 products so far. In particular, *"I Tesori della Terra"* – the biological yogurt producer involved in the Proof of Concept campaign – demonstrated a strong interest to the features offered by the system. The use of the App for QR reading is still scarce, but this is linked to the prototypal nature of the application and service. Installation and utilisation of the App is expected to grow as soon as the operational service commence.

The CNST intends to use the GALIST service to support the certification of White Truffles – with a weight over 50gr – according to the disciplinary of the CNST. The disciplinary is defined according to international standard for the product certification.

This disciplinary foresees a board of expert evaluators, part of an official data base of authorised experts, with the task to evaluate each truffle against three sets of quality indicators:

- Tactile evaluation;
- Aesthetic evaluation;
- Olfactive evaluation.

Each member of the board, usually between 3 and 5 experts, gives a mark for each parameter inside the three sets. One of the experts acts as the chairman and has the task to make a synthesis on the quality certification providing the average/overall mark to the truffle.

The procedure foresees the filling of a paper template to record the marks and the final score assigned to each truffle (score between 0 and 5).

The certification, subject to the achievements of predefined thresholds on the score, is given to each truffle by means of a special paper label, with a unique identification number for each single truffle affixed to it. The final consumer can have the evidence of the certification thanks to the label, its identification number, and other graphical elements present on the label (see picture below).

Figurer 10: A truffle with CNST certificate and QR

The GALIST service has been evaluated by CNST as a useful tool to improve the value of the certification service, in particular with the validated geolocation of the certification event itself.

The GALIST SW is now fully integrated with the CNST operational process, and the disciplinary has been modified to include the GALIST tag production.

This approach foresees the recording of the certification board report on a Personal Computer where the GALIST SW ensures the validation of the associated position (location, time).

The GALIST App for smartphone allows any consumer to read the TAG and to get the confirmation of the certification, date/time of the certification, and information about the validated position (signature). The App is also an easy portal to get more information on the CNST and their mission, including the direct access to their website.

The market of the White Truffle is truly international, and most of the customers are very interested in obtaining 100% guarantees on the genuine origin of their purchases, and associated certification from the CNST. A Truffle with CNST label has a value on the market, without the label it does not have any guarantee. The GALIST service is expected to amplify this guarantee with a state of the art technology.

4 FURTHER STEPS

The GALIST Project is demonstrating a strong interest towards the food market.

In particular, the CNST has been so interested in adopting the GALIST system in the frame of its "disciplinary" that amended it, as to include the operational use of the GALIST service.

This is regarded as a great success for the project, and the feedbacks are very positive.

The lesson learned from the pre-operational provision of services for *CNST* and "*I Tesori della Terra*" allowed for the gathering of a deep knowledge of the users' needs. The prototype has been in fact implemented to fully support such operational needs. Thousands of products have been labelled and sold, and contacts are going on to improve the system as needed to support actual operational use.

Such a deep insight on the operational needs for the manual certification process has been reached. Discussion is going on with other producers to identify the most suitable approach for a next step of integration: an automatic labelling approach at a reasonable cost.

The main differences of the automatic certification versus the manual certification lies upon the industrial equipment for automatic labelling and ultra-fast QR code scanning.

The prototype fully supports the automatic certification case, and, as a result, it has passed the performance test based on a simulated high throughput scanner.

As a concluding remark, the customer experience in adopting the prototyped service paves the way for the industrialisation of the service and its integration within a complex industrial environment, as required by the automated labelling process. And this will be the next step for the system's intended evolution.