EUSATfinder

EUropean Space, Aerial and Terrestrial assets supporting first responders' operations

by GEOmedia Editorial Team

Natural disasters - intended as hurricanes, landslides, fires, avalanches, flooding, earthquakes, industrial accidents, terroristic attacks, eruptions, pollution, etc... - have been seriously threatening the well-being of the global society. Over the past 50 years, more than 11,000 disasters have been attributed to weather, climate and water-related hazards, involving 2 million deaths. While the average number of deaths recorded for each disaster has fallen by a third during this period, the number of recorded disasters has increased five times and the economic losses have increased by a factor of seven.

Current findings from the United Nations Global Assessment Report on Disaster Risk Reduction (DRR) points out that the economic loss from disasters such as earthquakes, hurricanes and flooding range from US$250 billion to US$300 billion each year. In this context Space assets, such as satellites and remotely piloted aircraft (drones), can play a crucial role in emergency response and disaster management.

EUSATfinder purpose: an innovative integrated and scalable solution to support first responders

The purpose of the EUSATfinder is to provide an innovative integrated and scalable solution to support first responders in real-life during different operational phases and improving citizens wellbeing. In particular, in the tactical phase, EUSATfinder aims at improving the intervention capability and reducing the reaction time using shared capacities from different governmental (GOVSATCOM) and private satellite systems interoperable with terrestrial communication services. The main objectives of the project are as follows:

- **Objective 1** -Secure and Reliable SATCOM/ Terrestrial infrastructure building up
- **Objective 2** - Concept of operations exploiting Secure and Reliable SATCOM
- **Objective 3** - BVLOS Drones Operations using Secure and Reliable SATCOM
- **Objective 4** - Monitoring and mapping for situational awareness
- **Objective 5** - Awareness and outreach in the context of GOVSATCOM HUB

Secure and Reliable SATCOM/ Terrestrial infrastructure building up (Objective 1)

EUSATfinder aims to provide an improvement/ reestablishment of in-situ communication with a quick to deploy, resilient, robust infrastructure avoiding the usage of already pres- ent infrastructure which can be compromised or not existing at all, by means of SATCOM and „ad hoc“ integrated terrestrial networks:

- Usage of a combination of secure SATCOM services (including GOVSATCOM service and Non-European narrow-band, i.e. 1 GEO FSS, 1 GEO MSS, 1 LEO MSS);
- Integration with 1 scalable proprietary terrestrial network integrated with the SA- TCOM services;
- Usage of 1 patented innovative LightAway for fast SATCOM infra deployment on situ customized for compliant with Athena Fidus Italian and French payloads;
- Usage of 1 innovative dual system for SATCOM able to work with Athena Fidus and VHTS Kon- nect
- Usage of 1 Mobile Operation Center to distribute communication and data processing ac- cording to the operational chain of command.

Concept of operations exploiting Secure and Reliable SATCOM (Objective 2)

USATfinder aims to provide an improvement/ Optimisation of Concept of operations exploiting secure and reliable communication to manage first responders‘ activities and for alerting citizens in distress based on the integrated satellite, aerial and terrestrial infrastructure

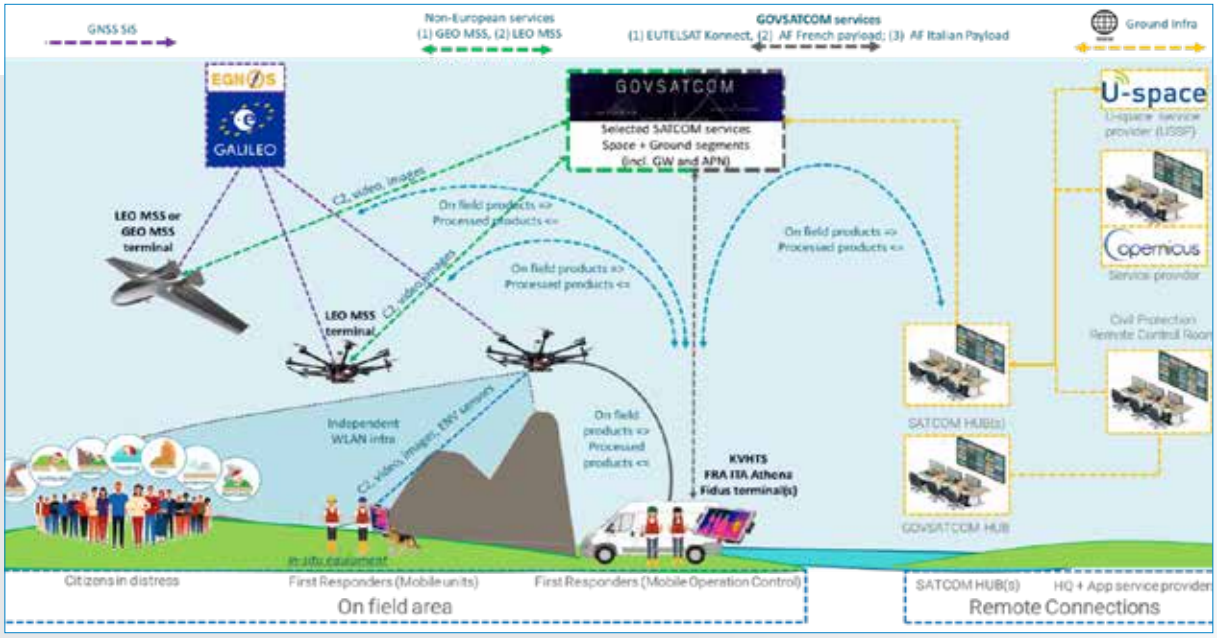

Fig. 2 - EUSATfinder concept: from Training to in-situ preventive and real time monitoring

deployed during the tactical phase of the emergency.

Test of 2 portable and mobile apps/tools used by:

- First responders during tactical operations allowing to share info also to citizens potentially in distress with the involvement of transnational first responders' which will be equipped with a mobile terminal to receive filtered data and to share location and ancillary parameters;
- Citizens in distress, having the possibility to be connected and geotagged/ localised when the terrestrial network is built-up. Operational cooperation between 2 different sites, managed by different teams of first responders

BVLOS Drones Operations using Secure and Reliable SATCOM (Objective 3)

EUSATfinder aims to provide a contribution to enable (technology and standard) the operation of Remotely Piloted Aircraft Systems (drones) and communication with their onboard sensors, including BVLOS scenarios where C2 and mission data are exchanged using an integrated SATCOM and terrestrial network interfacing with the U-Space Service Provider USSP for common criteria and standardised operations:

- On field data collection using a fleet of 3 categories of drones (fixed wings, rotary wings and tethered) with different features equipped with SATCOM transponders and Galileo OSN- MA enabled receivers;
- Interface with the 1 USSP (Italy) using an integrated SATCOM and terrestrial network. Drones will be equipped with a GNSS tracker Galileo OSNMA enabled.

Monitoring and mapping for situational awareness (Objective 4)

EUSATfinder aims to perform real time monitoring and mapping for situational awareness, by collecting real-time processed images and videos, forwarded to the in-situ MOC and to a remote center for processing:

- Usage of Copernicus EMS and CLMS products also integrated with in situ data integrated in a unique map;

EUSATfinder contribution	Novelty
Usage of 3 GOVSATCOM GEO FSS services ▸ ATHENA Fidus (AF) ITA payload; ▸ Athena Fidus (AF) FRA payload; ▸ Konnect.	▸ Implementation of LightAway (mobile and portable terminal) for AF ITA + FRA payloads; ▸ Customisation of TPZ dual satellite terminal for ATHENA FIDUS ITA and VHTS Konnect
LEO MSS service usage	Usage of LEO MSS for drones C2 and mission data
GEO MSS service usage	Usage of GEO MSS for drones C2 and mission data
Ad Hoc Terrestrial infrastructure including extending local coverage with meshed network	Fast building up of a secured and integrated terrestrial SATCOM network with significant coverage extension
Mobile Operational Center (MOC)	Building up of a mobile station integrating on filed sensors for quick operations

Tab. 1 - Objective 1

EUSATfinder contribution	Novelty
Tools for first responders' operations	Dedicated tools and mobile app for first respon- ders' operation tested on a secure SATCOM channel
Tools for citizens in distress/ emergency situation	Dedicated mobile app for citizens in distress tested on a secure SATCOM channel

Tab. 2 - Objective 2

EUSATfinder contribution	Novelty
Boreal drone configuration	Fixed wings operations (C2 and payload data) with GEO MSS and LEO MSS
ATMO and TSP (Tethered) drones configuration	Rotary wings operations with (C2 and payload data) LEO MSS and integrated terrestrial Network
OSNMA Galileo service	Usage of Galileo/ EGNOS enabled receiver on board the drones for GNC (e, g. OSNMA service)
U-space Service Provider interfacing over integrated SATCOM	U-space service (e-tracking over SATCOM)

Tab. 3 - Objective 3

EUSATfinder contribution	Novelty
Copernicus EMS and CLMS products over integrated SATCOM	Products exchange (return and forward links) over distributed sites in the on-field area and remote HQ, including both C2 and mission data of drones for situational awareness. Copernicus tools and services will be used exploiting both mid-resolution (Sentinel-2 & Landsat) and hi- gh-resolution (SPOT 5/6) optical multispectral images to provide geomorphological evolution of the target area
Situational awareness over integrated SATCOM	
In situ Mapping over integrated SATCOM	

Tab. 4 - Objective 4

EUSATfinder contribution	Novelty
GOVSATCOM HUB (G-HUB)	Interfacing analysis coherently with G-HUB road- map
Transnational cooperation	Operational cooperation between 2 different sites, managed by different teams of first responders

Tab. 5 - Objective 5

- Usage of real-time processed images and maps collected from the fleet of drones and other Sensors;
- Real time surveillance using an integrated SATCOM and terrestrial ad-hoc network

Awareness and outreach in the context of GOVSATCOM HUB (Objective 5)

EUSATfinder aims to disseminate towards to first responders' institutional organisations and citizens the EUSATfinder context exploiting GOVSATCOM resources:

- Analysis of GOVSATCOM HUB managing pull and share of 3 GOVSATCOM service providers, namely ATHENA Fidus FRA, Athena Fidus ITA and VHTS (KONNECT);
- Involvement of at least three (3) Stakeholders to manage operations during the demo managed by Autonomous Region of Valle d'Aosta and Civil Protection competence Center;
- Arrangement of at least three (3) events with large audience (citizens and Institutional organizations).

EUSATfinder System Concept

The purpose of the EUSATfinder is to provide an innovative integrated and scalable solution, to support decision maker actors in real-life during different operational phases (detection, preparedness, response, recovery and mitigation of emergencies) with particular focus to first responders' activities in situ for a disaster management.

The solution is based on a mobile operational centre (MOC) able to join in the proximity of the emergency area and to deploy several assets to

support the operations:

1. a quick to deploy resilient communication infrastructure;
2. a fleet of heterogenous drones for mapping (integrated with Copernicus Emergency Management Service), for extended environmental surveillance and for people and asset localisation;
3. innovative equipment for first responders' health monitoring and localisation (Galileo);
4. a distributed platform for First responder operations and citizens alerting management. Galileo adding an additional layer of security against spoofing are clearly new coming valuable services supporting drones' operations (including U-space) for these emergency applications.

Moreover, Copernicus data will be integrated with in-situ observations in the Mobile Operational Control (MOC).

EUSATfinder Core Connectivity

The core connectivity of the proposed architecture is represented by the CNES and Telespazio SATCOM HUB located respectively at CNES premises and at Fucino TPZ Space Center, acting as the hub towards all satellite systems involved, either directly (Athena Fidus) or via APN and PoP interconnected to their gateways (Iridium, Inmarsat and VHTS Konnect). This SATCOM core connectivity will also connect the „ad hoc" emergency telecommunications infrastructure to the external world (national agencies, processing facilities, data repositories) guaranteeing the integrity of the exchanged data and protecting from cyberattacks. It is essential to note that the mobile control center located at the emergency area will have only security protected interfaces to the external world, acting by all means as an extension of the SATCOM HUB that have the role to secure the interconnection to the external world. EUSATfinder connectivity includes 3 GOVSATCOM services and aims to study non-European narrow band service providers (LEO MSS and GEO MSS) to provide recommendations for future European services not yet available.

Natural Disaster Validation Test

Hazard management in a previously monitored area

In CPA (Civil Protection Authorities) practices, the need for intervention criteria based on quantified risk is rising and becoming decisive for implementing effective disaster risk reduction strategies. Geohazard management and mitigation practices involve the correct choice of the monitoring system (remotely sensed or in situ), the selection of the geohazards to be prioritized (in terms of allocated resources), and the development of a real-time or near-real-time monitoring service with ad hoc alerts based on

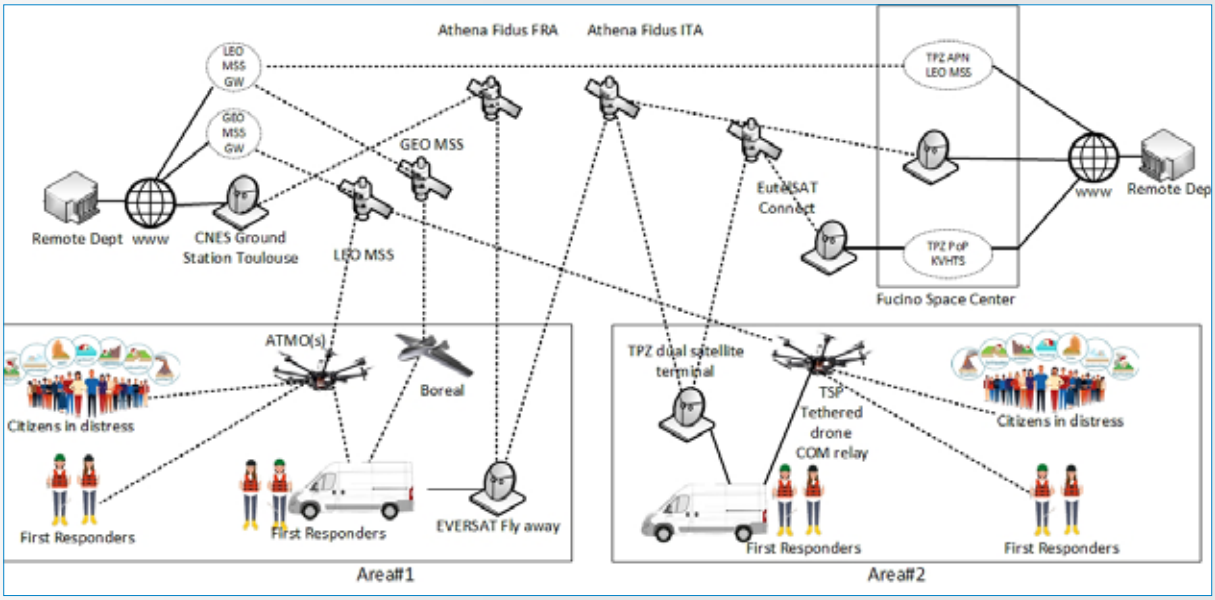

Fig. 3 - EUSATfinder System Concept

thresholds. At a regional scale, it is crucial to have a solution enabling the CPA to investigate the largest possible extension of the territory and to detect new hazard phenomena or changes of the existing ones as early as possible. This screening capability provides the CPA with the opportunity to perform a full-scale regional assessment of the geohazards, with a proper allocation of human and financial resources. From an operational point of view, an efficient monitoring solution should be able to be deployed in all the different operational phases of disaster management: i) prevention and preparedness, ii) emergency and response, iii) recovery. EUSATfinder system shall provide a scalable, portable and usable solution in order to configure the proper architecture depending on the selected phases. Therefore, it is worth highlighting that a robust regional monitoring system integrated into the CPA cycle requires multi-source techniques to retrieve the most reliable and complete information possible. Moreover, effective communication among first responders during and in the aftermath of a disaster can affect outcomes dramatically. There is a concrete need to build a resilient architecture that allows first responders to communicate even with:

- damage to infrastructure – civilian and/or specialized communication facilities may be damaged by the disaster;
- congested channels – because affected people report something about the disaster, and these messages may be broadcast;
- dynamically formed groups – first responder teams may be formed dynamically in response to a disaster and team member addresses (e.g., phone numbers) may not be known to one another;
- impediments to communication – because the new command chain to manage the disaster may be different from the original organizational hierarchy;
- poor interoperability – each sub-team might use different communication facilities, and it could be different to have the possibility to communicate with the whole involved persons.
- security attacks – disaster situations are often vulnerable to attacks, requiring authentication and authorization as well as establishing data integrity and provenance;

The Planpincieux Glacier, a hanging glacier located on the southern slopes of the Grandes Jorasses in the Mont Blanc massif is a temperate glacier largely investigated in the last decade with optical cameras and meteo station to analyse the dynamics of ice collapses. The lower (terminal) part of the Planpincieux

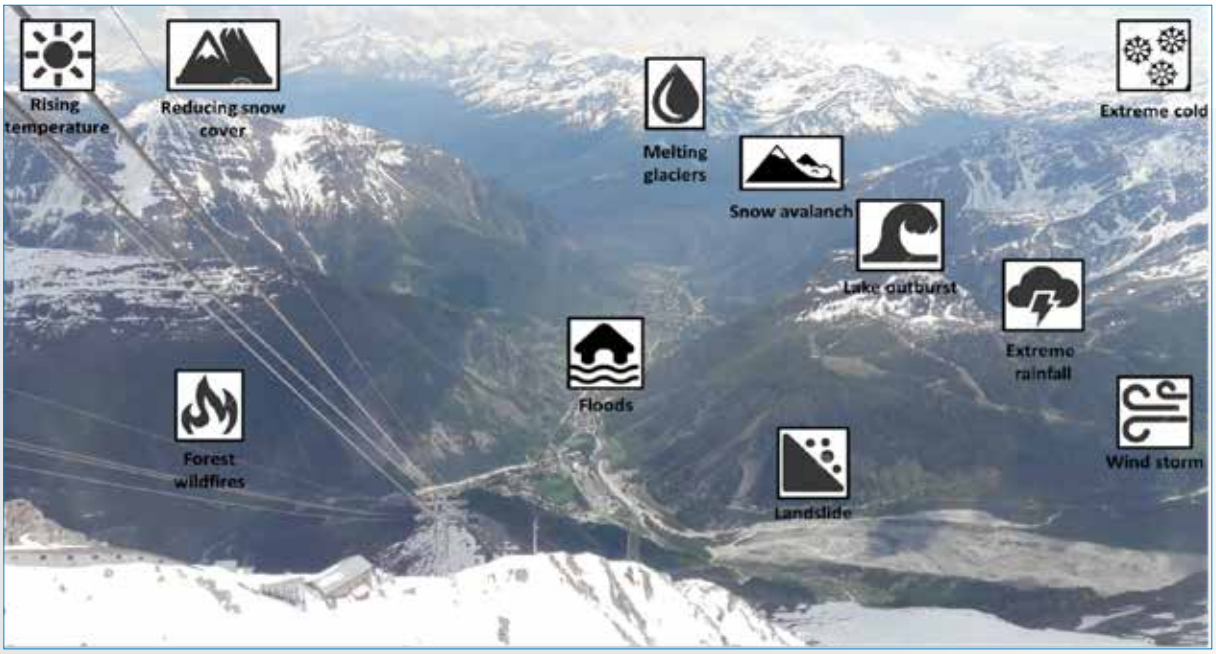

Fig. 4 - The Aosta Valley seen from Pointe Helbronner (Mont Blanc massif). The municipality of Courmayeur is seen with the valley floor. On the right the lower section of the Brenva Glacier, on the left the entrance of the Val Ferret. Valle d'Aosta climate-related hazards: crucial issues in the light of the accelerating global warming, because of which regions in the alpine settings are increasingly experiencing warm weather patterns.

glacier is very active and characterized by the presence of crevasses and seracs, and collapse phenomena that make these areas difficult to access and very dangerous. The difficulty of access is high especially in the suspended glacier front. Over the years, several ice avalanches and glacial outburst floods have occurred that posed a threat to the hamlet of Planpincieux at the bottom of the valley. Over the years, several ice avalanches and glacial outburst floods have occurred that posed a threat to the hamlet of Planpincieux at the bottom of the valley. In September 2019 and August 2020, the access roads to Val Ferret were closed and the evacuation of population was ordered after experts warned that some 500,000 cubic metres of the glacier could break away, potentially affecting the access road to the Val Ferret valley. The Val Ferret is also affected by landslide of different typology. Beside the historic large (volume of 10 million of m3) rock avalanche of 12 September 1717 interesting the moraine complex of Triolet Glacier in the highest sector of the valley, in August 2018 a debris flow of 25,000 m3 of volume and a front of the slide of around 700 meters occurred. After intense rainfall a major mudslide swept through parts of Val Ferret, claiming two people and determining 320 evacuees.

Natural disaster in an unexpected area

The territory of Valle d'Aosta is potentially affected by a series of natural extreme events on which it is vital an effective solution for context awareness and extended surveillance. The severe flooding occurred in October 2000 is an example. On 16th od October, after several days of persistent and intense precipitation involving the entire Region, extensive flooding and landslides occurred for more than 500 million euro, thousands of evacuees and several life losses in the population (20 persons died in the Region). In case of emergency generated by one of the different hazards, the integration of the complementary systems and sources strengthens the monitoring of the events. In fact, data collection during natural extreme events can be difficult and it represents a serious hazardous condition for involved personnel. With respect to such scenario, the capability of assessing the situation, in terms of awareness, becomes a hard task to be solved in a very short time to enable possible countermeasures or evacuation actions.
In case of emergency, EUSATfinder system will provide a solution allowing near real time video-streaming in order for a remote operator to extend his / her situational awareness. This shall include automatic detection of hazard phenomena, essential for defining the impact zones of harmful phenomena.
Operations can include:

- investigation of remote, inaccessible and uninhabited areas (in the case of Valle d'Aosta Region, the high mountainous environment), with a proper recurrence time in data acquisition;
- prioritization of intervention

Fig. 5 - The Planpincieux Glacier (left side) with the terminal part at high risk of collapse. The landslide event of August 2018 (on the right side) which wiped out several cars and a couple lost their lives after their car was hit.

areas where to orientate the Search and Rescue activities;
- appreciable and positive impact on the safety of the personnel involved in Search and Rescue activities;
- assessing distribution of hazard extension (e.g., mapping material in case of landslide/avalanche);
- mapping areas affected by the event (e.g., flooded areas in case of inundation);
- recognition of residual hazard in the areas close to the collapsed area;
- control and monitoring of evacuated areas with high resolution imagery in wide settings or to operate during day and night;
- recognition of residual hazard in the areas close to mapping the destroyed area;
- provision of a constant stream of data, to be used to control and monitor evacuated areas;
- research and rescue of injured in case of emergency event (e.g., snow avalanche)

EUSATfinder project main features

SATCOM services under test (1)
An important objective of *EUSATfinder* is to test different SATCOM services integrated with a terrestrial network, providing several configurations to cope with the identified use cases. The experience collected during the demonstration campaign will allow *EUSATfinder* consortium to provide recommendations also for future European SATCOM network as being identified in IRIS2 initiative. In particular, the project will analyze how this managed service will be coordinated by the GOVSATCOM HUB.

GEO FSS: Athena Fidus: a European SATCOM service to support GOVSATCOM concept
GEO FSS is one of the core components investigated in EUSATfinder; ATHENA Fidus has been identified as reference solution being a European constellation designed for military and civilian emergency situation which is the core scope of EUSATfinder. Athena-Fidus (Access on THeatres for EuropeaN Allied forces nations-French Italian Dual Use Satellite) is a civil-military satellite developed by France and Italy to provide broadband telecommunications services for armed forces and civil protection teams in both countries. CNES manages a French civil capacity on Athena-Fidus satellite with its own experimental ground station (also known as SEXTAN). This French civil capacity covers the French metropolitan and some areas within its neighboring countries due to the beam form. Telespazio manages the ASI gateway on Italian civil capacity located in Fucino Telespazio Space center. To demonstrate the interoperability the demonstration location will be covered by the French and Italian civil beam.
In both the sites are present SATCOM terminals connected to the ground stations in order to manage and to provide IP / Internet connectivity to remote satellite terminals used by end-users located in the civil beams/zones. Thus, the CNES and the Telespazio own SATCOM platforms provide a wireless and secure IP connectivity to end-users thanks to satellite terminals and without any terrestrial infrastructure close to the intervention area. For the *EUSATfinder* project, CNES will provide, during the demonstration, a satellite broadband connectivity to first responder staff (Mobile Operation Control unit) on the on-field area

in order to communicate with the Civil protection remote control room. The same will be provided by Telespazio through the Network Control Center collocated in the Fucino Space Center. The Telespazio, in its role of Communication Service Provider, has in the NCC the control center of all the operation related to its services. The satellite communication will be able to send drone videos or images (via the drone remote command connected to the satellite terminal) to the remote control room. This communication solution would also be able to remotely control the payload (camera) of a wide-range drone.
An important activity undertaken in *EUSATfinder* refers to the implementation of compact and portable satellite terminals. A Telespazio COTP dual system (Konnect+AF) and a portable Athena Fidus terminal developed by EVERSAT. Through this terminals the remote first responders could be able to send videos or images and data from the on-field area to the remote control room with a high data rate. Two-way communication will also be possible from the remote control to the on-field area.
The LightAway satellite suitcase from Eversat is an innovative satcom terminal. This is the most easy to use and quick to air broadband portable terminal in the market. This rolling satellite suitcase is ideally suited for broadband IP connectivity (voice, video and high-speed internet communications). In addition, the LightAway satellite suitcase is a flexible platform. Depending on the satellite service, the end user can modify himself the RF and the modem to be adapted to the satellite service he wants to use. This satellite suitcase meets International Air Transport Association (IATA) weight and size limits and is airline checkable. The LightAway satellite suitcases are already deployed on the field and are used by many TV broadcaster, Military Special Forces and first responders (fire men, police squad, nuclear protection, etc.).
In the *EUSATfinder* project, Eversat will develop a new LightAway satellite suitcase compliant with Athena Fidus for both French and Italian payloads. Based on an award winning concept design by Eversat, the LightAway Athena will be deployed and used with no technical skills in less than 5 minutes. The LightAway satellite suitcase will integrate a RF transceiver, a modem and a battery pack for more than 2 hours of communication in the field.
In the *EUSATfinder* project, EVERSAT has to adapt the LightAway platform to be compliant with Athena Fidus satellite for both French and Italian payloads. The key performances of the new LightAway satellite suitcase Athena Fidus will be:

- Fast IP connectivity: 3 / 8 Mbps (upload/download)
- Secure IP connectivity
- Flexibility: compliance with both Athena Fidus French and Italian payloads (by switching the antenna feed arm and the modem)
- Easy to use; no parts to assemble and "one button" satellite autopointing,
- Quick to air; from suitcase (stow position) to satellite in less than 5 min by a first responder without satellite system knowledge/ background
- Easy to carry: 1 single rolling suitcase weighting less than 30 kg
- Autonomous in energy: integrated battery pack for 2h of communication in the field.

The LightAway satellite suitcase is a patented technology by Eversat. In the future, the LightAway platform could be also adapted to Eutelsat Konnect VHTS.

LEO MSS: Iridium analysis to provide recommendations for future European SATCOM

LEO MSS systems with appropriate constellation and coverage design can provide truly global coverage from/to small and lightweight satcom user terminals, thanks to the preferential link budget characteristics especially in L-band. The GEO FSS service described above may not be able to provide *always and alone* the complete end-to-end connectivity demand required in various first-responder situations and use cases, particularly for BVLOS drone operations. Hence the LEO MSS component shall be used in *EUSATfinder* to complement the core GEO FSS Athena Fidus system in appropriate manner, while retaining as much as possible the important security features and the benefits from the valuable CNES and Telespazio centers.
At the moment of proposal writing the proposed implemented solution in the project will be based on Iridium and its most recently available second-generation Certus service and terminals; However, it is important to underline that the LEO MSS component in the target scenario can become technically and strategically significantly stronger with any emerging (European) broadband satellite constellation network, like the envisaged IRIS2. It is important to notice in this context that

the ongoing 3GPP/NTN standardization roadmap underlines the importance of the L-band service frequencies, in which Iridium is working, now also as an integral NTN frequency, which shows that our approach with currently available and mature Iridium terminals and services can definitely be seen as a clear and targeted transition step towards such European satellite constellation future. This provides a perspective for very tight integration with European GOVSATCOM infrastructure as a development path for the *EUSATfinder* LEO MSS subsystem; this will be considered throughout the project in the system architecture, future-proof solution design and exploitation perspectives.
LEO MSS terminals will be used primarily onboard rotary-wing (octocopter) drones for their tight size and weight requirements, but also shown as an option on larger fixed-wing drones. The end-to-end communication between drone and the respective ground control station (GCS) is systematically used for C2 communications, (i) as complementary means for LOS flights but especially (ii) as sole means for BVLOS missions; moreover, it can be also used for limited-bandwidth payload communications: typically 22/88 kbit/s up/down for the current smallest Iridium Certus category. This proves to be sufficient for the most important payload data from the field such as position, sensor, IoT data, but it can also support still pictures or short low-resolution compressed videos if no strict real-time service is required. In the trials and demos of the project, the LEO MSS service will be used to verify in particular the following capabilities:

- multiplexing and prioritization of end-to-end C2 and payload traffic from the drone over Iridium satcom connected to the GCS located at ATM Wessling premises via the ATHENA Fidus secure link
- local network configuration with GCS co-located with Athena Fidus satellite terminal In all configurations and for all types of applications, we envisage to achieve end-to-end delays below 1 second for critical and prioritized traffic and less than 2-3 seconds for lower-priority data.

GEO MSS: Inmarsat analysis to provide recommendations for future European SATCOM

GEO FSS system doesn't fit all the use cases; when the drone operates beyond line of sight, when the radio link with the ground station and the FSS system is masked by obstacles, or when the area overflown is environmentally limiting (water, mountain, …). Also, it is important to underline that the GEO MSS component in the target scenario can become technically and strategically significantly stronger with any emerging (European) broadband satellite constellation network, like the envisaged IRIS2. *EUSATfinder* proposed solution also relies on a GEO MSS system. The terminal, placed in the body of the aircraft, can send its data to the remote control centre located anywhere on earth. The advantage of a GEO MSS system is its global coverage. It is possible to stay under the same spot, without any handover, during a whole flight. We can also reach higher throughputs and maximize the bandwidth. The challenge we face while choosing an MSS terminal for UAV, is its size, its weight but also the attitude of the carrier.
In the *EUSATfinder* project, we will consider a GEO MSS service provider such as Inmarsat. Its L-Band satellites cover France and Italy, where the tests and demos will take place. In order to reach the highest performances, an electronically steerable antenna will be used. This technology consists in an array of small antenna elements that are electronically controlled to point in different directions, without any mechanical movement. This way, the beam is always directed towards the satellite, even if the UAV is heading to somewhere else. As an example, the Aviator UAV 200 terminal has been preliminary identified, which can manage to reach 200kbps bandwidth, which is enough to send videos or photos also for mission purposes.

GROUND: Integrated Terrestrial network (2)

Typical first responder scenarios will often see compromised, destroyed or non-existing terrestrial network capabilities. Still some ad-hoc terrestrial cellular technology can help to improve the EUTSATfinder offering of a quickly deployable, resilient, robust infrastructure, by means of meaningful integration of respective portable or mobile terrestrial network components. As a strong candidate for that we will further present an in-situ 5G campus network, but this can conceptionally be seen also as a good representative for similar solutions based on 4G or future 6G technology. Moreover, the 3GPP evolution with the emerging non-terrestrial network (NTN) architectures integrating 6G networks with satellite and aerial communica-

tions in a systematic and strategic way, is a strong motivation to put some focus exactly on that 5G campus network integration and inter-operability with both, (i) on-site drones and satellite terminals to provide extended in-situ access network capabilities, and (ii) the primary governmental and secure long-distance backhaul/backbone satcom Athena Fidus, via the shielding SATCOM HUB.
Clearly, the most important R&I challenge to be addressed in this context is the seamless inter-operability and handover between satellite and terrestrial communications networks providing overall secure governmental communications services. Initial simple but resilient interoperability and handover procedures are established and tested in the existing solutions used by partner ATM: these include full diversity of 5G and satcom links wherever available, mainly for C2 traffic, and fallback operation of satcom links for payload traffic when a cellular network is (temporarily) not available. Further more advanced handover protocols considering service prioritization (C2 over payload etc.) and optimized cost and performance routing in multilink scenarios are on the development roadmap and will be implemented and integrated in the EUSAT-finder solution.

SATNAV: Galileo OSNMA and GNSS anti spoofing (GSD) to support U-space interfacing over SATCOM (3)

In some scenarios involving first responder's operations, drones are required to have a communication continuity that needs to involve Satellite Communication services giving operators the ability to send and receive data beyond visual line of sight (BVLOS), enabling operations half a world away. The publication of the Manifesto for the development of D-Flight's U-Space services paved the way for the first U-Space services of Electronic Remote Identification Networking and Traffic Information (NRI). The actual U-space services lack of the full traceability of positioning data from its origin to final recording and storage.
Nevertheless, there is no mechanism put in place yet, to avoid any counterfeit of data from its origins to its permanent storage. For ensuring the full traceability chain with a high level of data protection against malicious attempts of data retrieval, altered records, meaconing, or spoofing attacks, it is important to guarantee the traceability of data from its origin, by implementing secure communication channels and reliable store data without the possibility of altering their content in the future. This last point is very important for many U-space services proposed by standardization bodies as Legal Recording, Digital Logbook, Tracking, Accident reporting/Investigation as well as for the new generation of proposed U-space services.
In our vision these services can be enabled by a rugged UTM Box The UTM Box is an EGNSS/IoT transponder mounted on UASs as an add-on (EFB - Electronic Flight Bag)

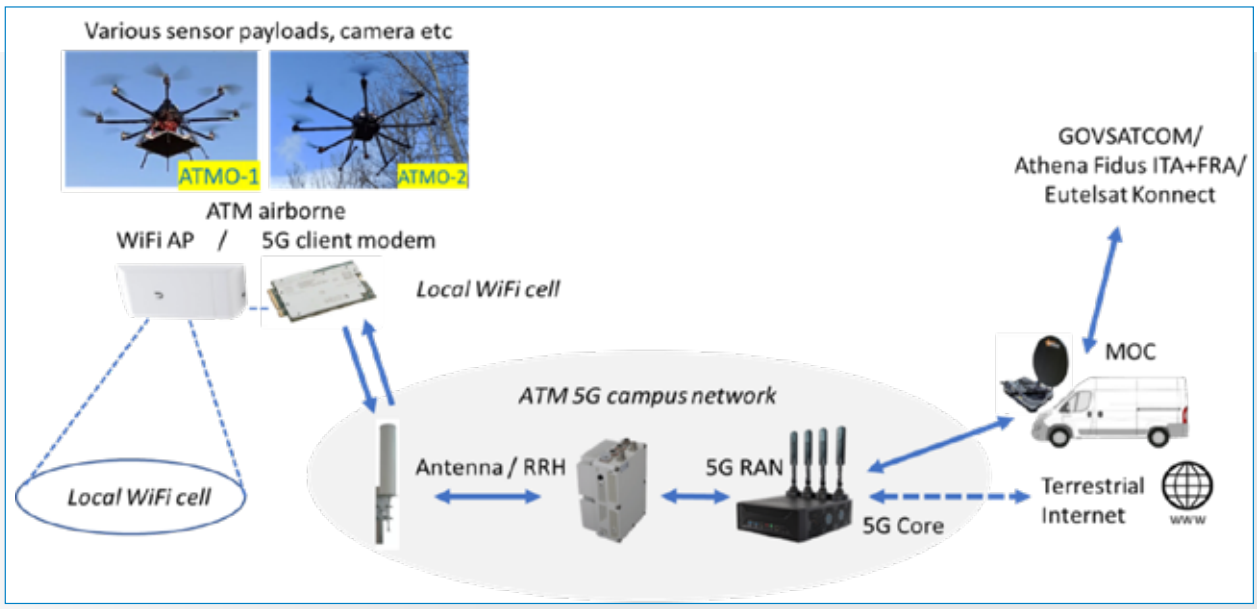

FIG. 6 - Terrestrial 5G network integration options.

on. It is the fundamental key enabler for EUSATfinder solution allowing to connect with the USSP. The UTM box will be designed having in mind robustness, reliability, and anti-tampering mechanisms, considering the successful experience of the previous model Pollicino® with basic tracking functionalities. The UTM Box envisioned for EUSATfinder will be addressed for UAS needs, with the same electronics, but different HMI.
The Innovative features of the new UTM Box can be summarized as follow:

- EGNSS OSNMA authentication (data secure from the origin);
- IMU Integration (Deep Kalman Filtering Algorithms for OSNMA / propagated solution coherence);
- UAS payload data integration to enable application specific data traceability;
- Cyphering mechanism for data authenticated tracking data transmission;
- Direct Remote Identification (DRI) and Network Remote identification (NRI) - EU regulation 2021/664 for General Aviation situational awareness and warnings;
- GNSS Raw data transmission to EUSATfinder platform (to enable Machine Learning anti-spoofing algorithms).
- Implementation of GNSS Spoofing Detection (GSD) function intended to guarantee the authenticity of data generated and location-related internally to the UAV (e.g. by the UTM Box), providing indications whether the estimated position is genuine or altered by a spoofing attack. In sysnthesis, the GSD function aims to discriminate between genuine (authentic) and altered (spoofed) signals to increase the protection provided by the Galileo OSNMA. The function, based on AI techniques, has been trained and validated to recognize the majority of possible spoofing attacks that can be carried out on a GNSS Receiver. In particular, the GSD function is able to provide information on:
  - the type of spoofing attack (e.g. meaconing, synchronized, advanced and SCER attacks)
  - the spoofed GNSS Constellations, frequency bands and satellites.

EO: Copernicus EMS, CLMS services and products integrated with in situ measurements using drones (4)
EUSATfinder foresees state-of-the-art 3D map integration of heterogeneous data (e. g. Earth Observation satellite + drone, several sensors). Now, data coming from different sensors will be integrated in a unique map. The photos will be acquired with an overlap of 80 to 90%. The 3D map or 3D model is then created using aerial image stitching photogrammetry software.
The drone will fly using autonomous programmed flight paths called waypoints. Each photo captured will also have its GNSS coordinates (Geotagging saved, which also assists to build the 3D map) to obtain the following products:

- DEM / DTM / DSM (surface models)

- Orthophotos (geospatially corrected aerial images)
- Volumetric Surveys

Concerning the Copernicus data and information, proposed activities within EUSATfinder will rely on both existing Services (Service Usage) and dedicated processing (Innovative Algorithm Implementation).
For what concern the Copernicus Services Usage, a particular attention will be devoted to two existing Services:

- the Cop*ernicus Emergency Management Service (EMS),* which has reached a very high level of maturity, being operational since 2012. The Rapid Mapping tool and products, as part of EMS Service, consist of timely geospatial information in support of emergency management activities immediately following disaster. The service is based on the acquisition, processing and analysis, in rapid mode, of satellite imagery and other geospatial raster and vector data sources, and social media when relevant.
- the *Copernicus Land Monitoring Service (CLMS)* provides a series of high-resolution geographical information on land cover/land use and their evolution at global scale. The products provided by High-Resolution Snow and Ice Monitoring of the CLMS contribute as an operational and a regular source of ice cover recordings within Europe, providing a critical parameter for a wide range of applications (water cycle, weather, hydrology, water management, natural hazards assessment). European Ground Motion Service (EGMS, part of CLMS), whose first baseline has been released in 2022, will be explored to map ground instabilities. Based on Sentinel-1 SAR data processed at full resolution, EGMS is conceived to provide for free seamless information regarding natural and anthropogenic ground motion phenomena over Europe, fundamental for landslide mapping and monitoring. Copernicus products is meant to provide tailored risk assessment for both recovery and preparedness phase of disaster management cycle. This product supports decision makers in localizing priority areas and helps defining mitigation measures.

With reference to the *Innovative Algorithm Implementation*, specific processing algorithms and procedures will be implemented to refine existing Copernicus tools and services exploiting both mid-resolution (Sentinel-2 & Landsat) and high-resolution (SPOT 5/6) optical multispectral images to provide information geomorphological evolution of the target area. In particular, the main envisaged scenario

will consist in the creation of satellite-based glacier mapping using optical multispectral acquisitions in order set up a monitoring approach based on glacier displacements, variations in the glacier morphology and environmental variables, such as air temperature, rain and snowfall. Algorithms based on co-registration, orthorectification, and sub-pixel correlation will be adopted to track the geomorphological evolution of glaciers in near real time.

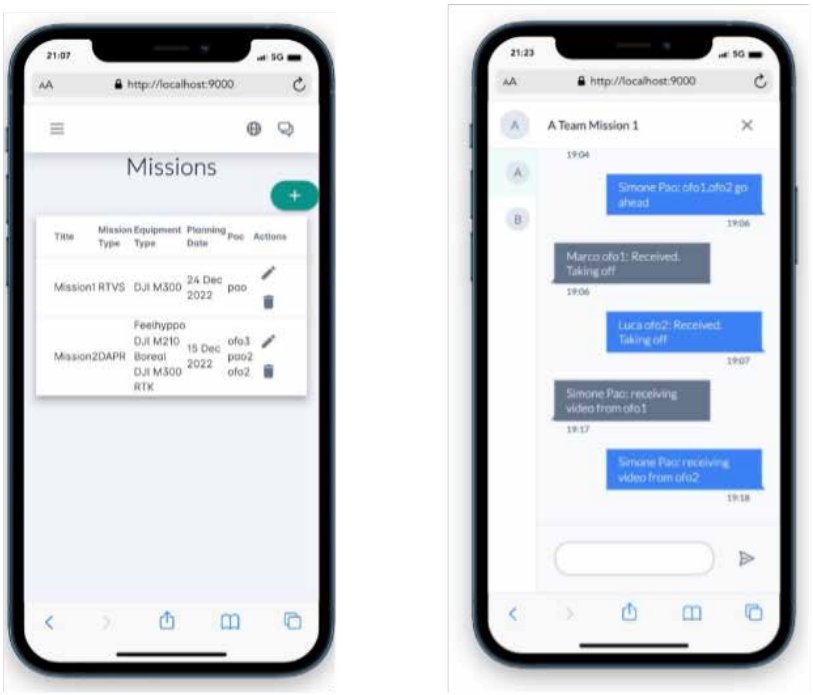

Fig. 8 - Sample of a potential mockup to be customized for both first responders and citizens.

MOC: Operations with the On site Mobile Operation Control (5)

A core segment of the EUSATfinder solution is the implementation of Mobile Operational Center (MOC), aiming to provide an easy to deploy in-situ center to support first responders' operations in a cost effective, efficient way. The proposed concept includes one (1) Van equipped with the following assets:

- A fleet of drones selected in number and category depending upon the type of emergency;
- Gateway communication infrastructure to civil protection remote control room(s) and external services as Copernicus and U-space UTM providers exploiting state of the art COM links (via satellite or terrestrial incase the MOC can be placed on a covered area);
- Secure Local independent Communication infrastructure M&C based on 802.11 or equivalent standards and equipment installed on board of a tethered aerial drone, providing in continuity a coverage of a order 10 Km radius as a core backbone available without interruption during real time operations for first responders in the field and to collect data from environmental sensors dropped by the fleet of drones.
- Ground Mission Segment (GMS) and Ground Control Segment (GCS) to manage the fleet of drones. The mission module will be based on tailoring of product inherited for mission preparation and execution. That modules will be designed to have a unique interface versus U-space services for all the fleet of drones. It includes command&control, telemetry transmission, video transmission and recording, Artificial Intelligence, mapping and 3D reconstruction algorithms.
- Integrated Mapping platform merging drones and EO (Copernicus EMS CLMS) data collection as well as processes about planning, acquisition, processing and final reporting.
- Connection to a Mobile application to allow first responders or citizens users to be connected when entering the ad-hoc WAN for message exchanging and context awareness.

UAV: The EUSATfinder fleet of drones (6)

Fixed wings drone: Boreal with GEO MSS and Galileo OSNMA enabled GNSS Rx

The BOREAL drone system is composed of a less than 25Kg fixed wing with high endurance (1000km, 10h of flight) and with large payload carrying capacity (5Kg). Among the applications and due to its great endurance, the BOREAL system has demonstrated its relevancy for surveillance called ISR (Intelligence, Surveillance,

Recovery) as well as for experimental applications thanks to its payload capacity, its robustness and its volume available for the payload.
In complement to rotary wings UAVs, fixed-wings drone will be used in *EUSATfinder* for long range flight/missions. In this respect, M3SB will bring to the project its long range fixed-wing drone, named BOREAL. It is a system that consists of a vector of type fixed-wing (4 m wingspan) with rear engine. This configuration gives it great stability in flight, associated with a significant payload capability (up to 5 kg) and flight duration of up to 10h.
The main interest on this solution is to ensure the surveillance on area size that cannot be covered by rotary wings solutions.
In *EUSATfinder* project, two configurations of the BOREAL drone will be used. With the ISR (Intelligence, Surveillance, Recovery) drone equipped with a gimbal camera which permits to covers a scene with real-time transmission of HD video via the UHF link.
The First version will be equipped with a camera, on-board processing capacity and a SATCOM modem for images transmission via INMARSAT whereas in the second configuration an IRIDIUM service is used provided by TPZ. In addition, "pollicino" tracker box is used for integration to the U-Space service provider USSP in Italy via SATCOM communications.
The ISR configuration of the BOREAL, which is a COTS product, will be used for the project. It consists of a BOREAL vector equipped with a long-range VHF radio link for C2 and datalink (up to 80km), satcom link for C2 once beyond UHF reach. A day EO / night IR optronic turret is already installed in the ISR configuration. For the purpose of *EUSATfinder*, a GNSS record solution (Galileo enabled) will be installed as well, and the interface with the project infrastructure will be developed.

Rotary wings drones: ATMO(s) with LEO MSS and Galileo OSNMA enabled GNSS Rx

Atmosphere has developed two octocopter drones where the focus of operations has been and will subsequently be not the drone as future product, but particularly to use the platform for continuous optimization and verification of secure and performant on-board connectivity solutions for both, C2 and mission data. ATMO-1 and ATMO-2 drones are displayed in Figure 12. Due to the typical size, weight and flight duration limits of an electrical rotary-wing UAV, the on-board satcom terminal must be as small and light-weight as possible, and hence a LEO MSS solution has been chosen, more particularly a second-generation Iridium Certus terminal which is developed and manufactured by Atmosphere. Being an Iridium value-added manufacturer, ATM can bring airtime plans and further benefits of commercial satcom for R&D&I projects along inherently with the terminal.
The primary drone for the project will be the more powerful ATMO-2, which is in the max. 25kg category. The current standard payload consists of a 360° camera, a WiFi access point offering local connectivity to standard WiFi devices in the field, and a tailored 5G modem providing a backhaul link to a ground based 5G campus network. The satcom terminal may also be used for payload communications (besides its main task as the C2 BVLOS link), however with limited bit rate capabilities of 22/88 kbit/s up/down as the smallest Certus category. However not only relevant IoT and position data for typical first responder applications, but also still pictures or low-resolution compressed video can always be transmitted if there is no strict real-time requirement. A more recent upgrade with a highy efficient adaptive video streaming capability also allows real-time video with dynamic limitations in rate, resolution and field of concern. Reliable and secure C2 communication is provided over complementary links (UHF, 5G, satcom) and a spe-

Fig. 9 – UAVs

cific version of enhanced MAVLINK protocol by ATM. For the *EUSATfinder* flights in Italy, the drone will also be equipped a Pollicino GNSS tracker to achieve national USSP compliance.

Tethered Rotary wings drone: TSP system with Galileo OSNMA enabled GNSS Rx

Nowadays tethered drones are used in a lot of domains to provide a consistent support for surveillance purposes.
In each of the application fields reported in the above figure, the following needs are identified:

- **CONTINUITY:** Drones shall be able to fly for hours, allowing long endurance surveillance operations by day and night.
- **USABILITY:** Drones shall be robust, quick to use and deploy, (even in a mobile platform as reported in figure) providing an effective solution for persistent aerial surveillance.
- **COVERAGE:** Drones shall cover wide areas as many square kilometer in some cases and thus provide information for a complete situational awareness
- **SECURITY:** Drones have to be intended as an additional segment of the overall surveillance infrastructure and as consequence has to be protected against accidental and intentional attacks.

Based on the abovementioned parameters, a so called "**Tethered** solution" is a very interesting candidate for first responders operations consisting in coupling a drone with a fixed point on the ground (a hangar) providing power:

- Power over cable for extended flight time operations;
- C2 link data security & integrity through cable for spoofing rejection
- Physical constraint to limit the drone envelope of flight, easing authorization requests

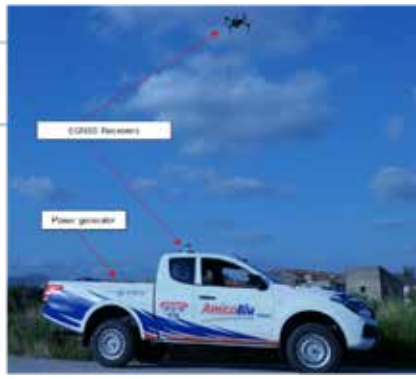

Fig. 10 - Tethered drone used on mobile pick-up

Moreover, The Tethered drone will be used as a Communication relay, with the following main components

- Hot Spot Station for Advanced Operative Center (COA) located with the MOC
- Master Thetered Drone (MTD) (UAV1)
- Hot Spot Station for Home Point (HSS

The bandwidth of the network will be adequate for real-time video streaming from the aerial drone and the underwater drone to the COA, simultaneously during the respective environmental monitoring operations.

NOTE
This project has received funding from the European Union Agency for the Space Programme (EUSPA), under the European Union's Horizon Europe research and innovation programme (grant agreement No 101180157).

KEYWORDS
Emergencies; first responder system; mitigation; Copernicus; Galielo; MOC; Earth Observation; SATCOM; SATNAV; Terrestrial Network; UAVs

ABSTRACT
The purpose of the EUSATfinder is to provide an innovative integrated and scalable solution, to support decision maker actors in real-life during different operational phases (detection, preparedness, response, recovery and mitigation of emergencies) with particular focus to first responders' activities in situ for a disaster management.
The solution is based on a mobile operational centre (MOC) able to join in the proximity of the emergency area and to deploy several assets to support the operations:
1. a quick to deploy resilient communication infrastructure;
2. a fleet of heterogenous drones for mapping (integrated with Copernicus Emergency Management Service), for extended environmental surveillance and for people and asset localisation;
3. innovative equipment for first responders' health monitoring and localisation (Galileo);
4. a distributed platform for First responder operations and citizens alerting management. Galileo adding an additional layer of security against spoofing are clearly new coming valuable services supporting drones' operations (including U-space) for these emergency applications.
Moreover, Copernicus data will be integrated with is-situ observations in the Mobile Operational Control (MOC).

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TEOREMA PRESENTA LEICA BLK ARC: MODULO LASER SCANNER PER LA CATTURA DELLA REALTÀ IN AUTONOMIA

Teorema di Milano, distributore ufficiale di Leica Geosystems da oltre 30 anni, offre le migliori tecnologie sul mercato nel campo di ingegneria, architettura, progettazione, rilievo e molto altro.

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In questo articolo viene presentato uno strumento che rappresenta un ulteriore passo in avanti nel campo della cattura della realtà:Leica BLK ARC , un avanzatissimo modulo di scansione laser autonomo progettato per eseguire rilievi 3D in completa autonomia.

Estremamente versatile, può essere utilizzato oltre che con robot, anche con paline e carrelli, per essere impiegato in molteplici campi di applicazione, dall'ispezione di infrastrutture alla mappatura di ambienti complessi. Cattura nuvole di punti 3D e immagini panoramiche.

Leica BLK ARC è l'unico laser scanner progettato per l'installazione e integrazione su mezzi robotici per la realizzazione di ispezioni automatiche ripetitive oppure per andare a catturare la realtà tramite funzioni di scansione statica e dinamica di grandi aree complesse o ambiente poco accessibili per l'operatore umano.

La tecnologia GrandSLAM combina LiDAR SLAM, Visual SLAM e IMU per ottenere le migliori prestazioni di mappatura con l'esecuzione di una scansione completamente autonoma mediante navigazione robotizzata.

È possibile mappare il proprio percorso di scansione da remoto utilizzando disegni esistenti o modelli BIM dell'edificio da rilevare, anche nel caso di spazi grandi e complessi. E una volta completata la missione di scansione, i dati sono pronti all'uso.

BLK ARC può essere montato su diversi tipi di robot come Spot di Boston Dynamics, ANYmal di ANYbotics o RB-WATCHER di Robotnik, utilizzando i propri sensori assieme a quelli del robot per creare missioni di scansione completamente autonome e replicabili.

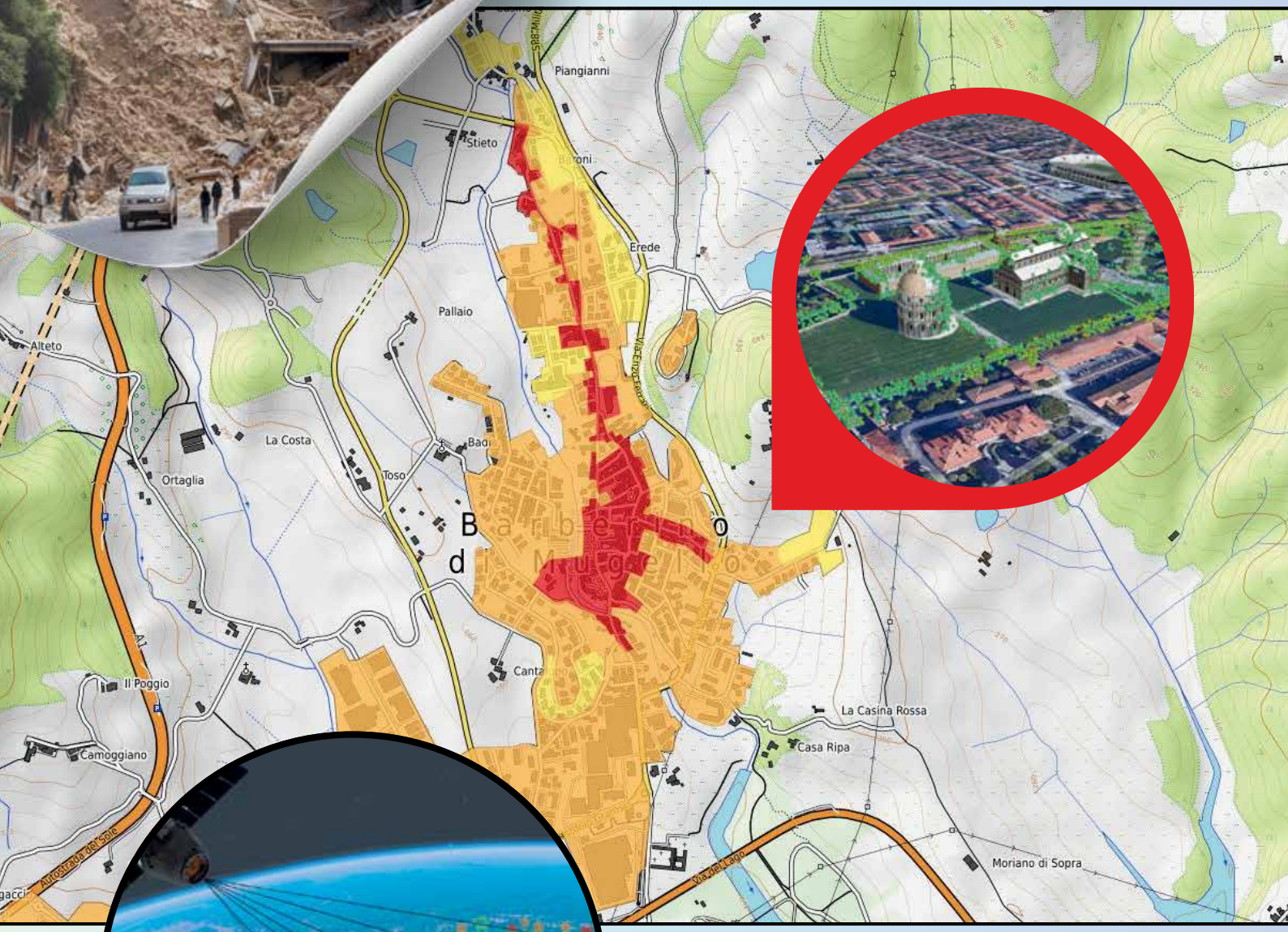
Leica BLK ARC può essere utilizzato anche senza un robot e ovunque: applicato su un supporto come una palina, un carrello o appeso ad un cavo. Può essere controllato tramite un tablet o uno smartphone con pochi semplici tocchi è possibile avviare le scansioni.

Su un supporto stabile sarà possibile realizzare delle scansioni statiche che hanno l'obiettivo di fornire un rilievo con maggiore densità di punti ed accuratezza per poi eventualmente combinarle con scansioni dinamiche oppure gestirle separatamente.

Grazie ai sensori GrandSLAM LiDAR, una fotocamera da12 Mpixel e un sistema di visione panoramica composto da 3 fotocamere da 4.8 Mpixel, permette la restituzione di una nuvola di punti colorata e di un'immagine panoramica a 360°.

Terminato il rilievo sarà successivamente possibile effettuare l'upload di dati dal BLK ARC alla piattaforma Reality Cloud Studio per la condivisione, archiviazione e visualizzazione dati.

IMMAGINA UN MONDO IN CUI LA GESTIONE DEL RISCHIO DIVENTA SEMPLICE, PRECISA E ACCESSIBILE.



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PIANI DI GISHOSTING

Dal 2016 Gter sviluppa e gestisce il servizio di hosting geografico GIShosting che consente di pubblicare in pochi e semplici passi dati geografici su web. Basato su QGIS Desktop, QGIS Server e Lizmap Web Client, non richiede particolari competenze per ottenere un webGIS completo di tutti gli strumenti necessari alla navigazione e consultazione della mappa e, grazie alla soluzione in hosting, non è necessario preoccuparsi dell'hardware e dell'aggiornamento software.

Gter ha pensato a diversi piani per rispondere alle diverse esigenze di chi ha bisogno di pubblicare su web le proprie mappe:

• il piano base per la semplice condivisione e consultazione dei dati. E' il piano più semplice, nonché quello più economico. Non include un DataBase PostgreSQL per questo funzionalità avanzate come editing online e ricerche spaziali non sono disponibili. Consente comunque di pubblicare un numero illimitato di progetti QGIS nella propria repository fino a 5 GB di spazio disco su server condiviso

• il piano full per chi ha una mole di dati più importante e che necessita di uno storage più strutturato e/o per chi i dati oltre a condividerli deve anche elaborarli via web. Include infatti un DataBase PostgreSQL con estensione spaziale PostGIS che consente quindi l'attivazione di strumenti quali appunto l'editing dei dati via web. Anche con questo piano è possibile pubblicare un numero illimitato di progetti nella propria repository fino a 10 GB di spazio su server condiviso equamente suddiviso tra disco e DB

• il piano private per chi ha necessità di creare un geoportale con diverse mappe pubblicate e suddivise per aree tematiche e di cui poter gestire utenti, accessi e permessi. Questo piano infatti, oltre ad comprendere tutte le caratteristiche dei piani precedenti ad esempio il DataBase, include un'installazione dedicata di QGIS Server e Lizmap. Ciò garantisce migliori prestazioni e maggiore autonomia nella gestione dei progetti pubblicati essendo l'utente amministratore di Lizmap. Oltre a pubblicare un numero illimitato di progetti QGIS è infatti possibile creare più repository, creare utenti e gestirne i permessi. Con il piano private lo spazio a disposizione su server condiviso è di 50 GB equamente suddiviso tra disco e DB

• il piano enterprise per chi vuole riproporre un servizio di hosting geografico ai propri clienti appoggiandosi all'infrastruttura server di Gter. Con questo piano l'utente è amministratore di tutte le componenti di GisHosting che vengono installate su un server dedicato e può di fatto riproporre un servizio analogo ai propri clienti personalizzando i domini web. Con il piano enterprise lo spazio a disposizione sul proprio server è di 160 GB equamente suddiviso tra disco e DB

Tutti i piani comprendono servizi di backup dei dati, aggiornamento software e assistenza.

Naturalmente Gter è a disposizione per installazioni su server di proprietà dei suoi clienti, propone infatti il piano local che, come il piano enterprise, consente all'utente di essere amministratore di tutte le componenti di GisHosting. In questo caso però i servizi di backup dei dati, aggiornamento software e assistenza non sono compresi nel piano ma attivabili su richiesta.

STONEX S590 RICEVITORE GIS & RTK

Il ricevitore GIS e RTK S590 è una soluzione progettata per i professionisti che necessitano di un posizionamento ad alta precisione anche negli ambienti più impegnativi. Rispetto ai prodotti GIS tradizionali, S590 può essere indossato per una maggiore libertà di movimento o fissato ad una palina se necessario.

Sistemi multi-costellazione e correzione PPP

S590 integra un sistema multi-costellazione che include GPS, GLONASS, BeiDou, Galileo, QZSS e IRNSS. Grazie ai servizi di correzione PPP disponibili (HAS e B2b), è possibile contare su dati di posizionamento estremamente precisi, personalizzati in base alle esigenze specifiche.

Alta precisione

Con una tecnologia avanzata che consente la registrazione di dati grezzi per il post-processing, S590 garantisce una precisione straordinaria. Questa capacità è fondamentale per applicazioni in cui la precisione è imprescindibile.

Tecnologia IMU

S590 è dotato di una tecnologia IMU all'avanguardia che consente un'inizializzazione rapida e misurazioni accurate anche con inclinazioni fino a 60 gradi. Questa caratteristica assicura prestazioni affidabili anche in terreni complessi.

Trasmissione dati

Rimani connesso grazie alle opzioni versatili di trasmissione dati, tra cui Wi-Fi, Bluetooth e radio esterna. Questa flessibilità consente una facile integrazione con i sistemi e dispositivi già in uso, semplificando il flusso di lavoro.

Soluzione per droni

S590 può essere utilizzato come stazione base per droni, migliorando significativamente la precisione e l'affidabilità delle operazioni aeree. La stazione base fornisce dati di correzione al drone (rover), garantendo una precisione al centimetro grazie al posizionamento cinetico in tempo reale (RTK). Questa funzionalità può essere facilmente attivata tramite l'interfaccia utente web. Inoltre, S590 può essere impiegato per misurare i punti di controllo a terra (GCP), migliorando l'accuratezza del rilievo cartografico.

RTK robusto

Progettato per durare, il S590 ha una certificazione IP67 che garantisce resistenza a condizioni difficili, come polvere e acqua. Questo design robusto lo rende ideale per l'utilizzo in una vasta gamma di ambienti impegnativi.

Con il Ricevitore GIS e RTK S590, la precisione e l'affidabilità incontrano l'innovazione tecnologica, offrendo una soluzione completa per le necessità dei professionisti sul campo.