

A SPACE-BASED HEALTHCARE EMERGENCY MANAGEMENT SYSTEM FOR EPIDEMICS MONITORING AND RESPONSE

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Abstract

A global pandemic such as COVID-19 highlights more than anything else the necessity of a robust technological infrastructure to support critical activities, digital healthcare services, hospital organizations, medical screening and first aid facilities.

The aim of the proposed solution is to provide an advanced healthcare monitoring and management system, covering national and international territory, exploiting spatial assets. The system architecture, illustrated in Figure 1, includes all the innovative elements taken into account to provide an efficient monitoring and management solution for fighting against wide epidemics. Medical screening kiosks, healthcare VANs (i.e. mobile caravan vehicles), IoT sensors interconnected through a hybrid communication system (both satellite and terrestrial) to a centralized cloud-based data center, provide a large healthcare screening and response network on the whole population which allows to help hospitals, medical and first aid units, rescue & military teams in pre-triage screening/prevention, monitoring and logistics activities for epidemics.

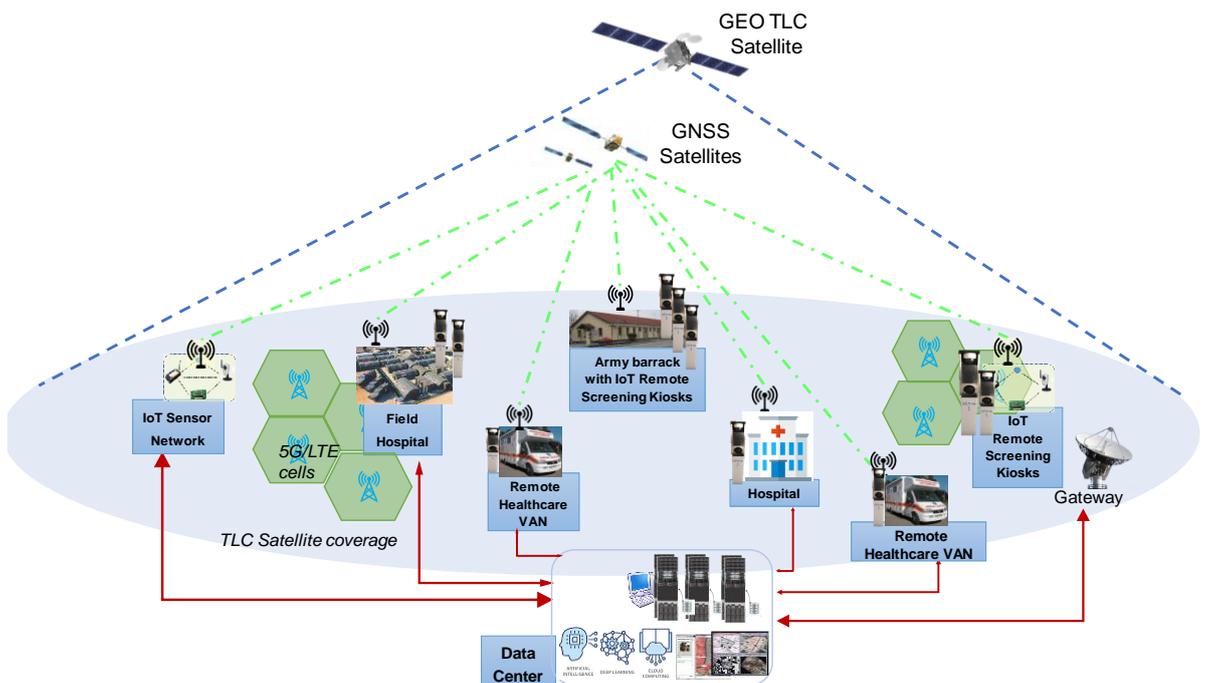


Figure 1: Space-based Healthcare Emergency Support System Architecture

The state-of-the art technologies of the described network will include: medical screening kiosks equipped with IoT smart-sensors, for the local collection/processing of body temperature measurements, blood oxygenation, heartbeats, symptoms of viral infection, screening with serological testers (e.g. Covid-19 screening testers, pulmonary fibrosis symptoms) and possible voice samples for novel voice-screening classification based on artificial intelligence techniques. The kiosks monitored by medical aid or army staff will allow, along the national/international territory, the collection of synthetic data and sending them via 4G-5G/Satellite to a centralized cloud-based system with advanced geo-information mapping capability (data center). The kiosks can be associated with mobile operating rooms, army barrack and field hospitals in areas where there are particular needs related to health emergencies. The operating rooms will be able to integrate the functionality of the kiosks with video consultation and remote diagnostics stations. Medical screening kiosk, IoT sensor and teleconsultation kit will provide in the field infrastructure a digitalization of the process in close cooperation with the central entity of sanitary excellence and data collection and processing.

The solution provides for the use of an infrastructure based on a Telespazio Hybrid Network implementing resilient high-capacity virtual connections by combining a multiplicity of physical connections based on different technologies (satellite, mobile networks, etc.) that operate simultaneously ensuring robustness of the connection, continuity and quality of service.

The screening data will be processed centrally with a Big-Data Analytics Platform based on AI / ML (Artificial Intelligence/Machine Learning) algorithms able to correlate and compare anonymous patterns of infected individuals, already known (training samples), with the data patterns of individuals analysed on the network. The AI / ML system will be able to train more and more on the basis of its algorithmic capacity of continuous self-learning.

The system will be designed also to provide support for the healthcare emergency logistical coordination for the optimal deployment of medical resources or for tracking the patient's medical swabs transported to/from test analysis laboratories along the local territories. To this end this work will study also, as a crucial strategy to handle the emergency, the ability to share information and develop tools for exchanging epidemics and science analytics data in real time.

Outbreaks, such as COVID-19, would be then strongly supported at central level with an integrated environment of multi-dashboard geo-information data analytics, aiming to provide secure access to science and logistic support information profiled for different user communities (public institutions, commercial operators, operators of emergency services).

Finally, in this paper the architecture of the proposed space-based healthcare emergency management system will be presented by describing the main components relying on innovative IoT sensing technologies, processing and response concepts enabling: i) the acquisition and collection of healthcare sensor screening measurements in a central big-data repository for further analysis and correlation; the ii) *logistic data analytics*: the healthcare emergency logistics/geo-localization functions for the optimal deployment and tracking of medical resources; iii) *science data analytics*: the geo-information data analytics of the epidemiological flows during large epidemics.