ENERGIC-OD
How a pan-European Virtual Hub eases the use of Open Data

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Summary
The pan-European Virtual Hub (pEVH), developed as part of the ENERGIC-OD European project, facilitates the usage of geospatial information open data to all users, and SMEs in particular. It is a single point of access to a wide range of datasets. It brokers major open data platforms, and provides added-value services including semantic discovery for multilingual metadata, and data format harmonization. The pEVH services are accessible through a geoportal developed by ESA and through standard services and dedicated APIs for developers. Basic functions of the pEVH will be available for free to all users, with some premium features accessible for a low charge (thus embracing the freemium revenue model). The pEVH will function until at least the end of year 2020, and it bridges the gap between a sustainable business model around open data commercialization, as well as bringing research-driven project outputs to the market.

Zusammenfassung
Der paneuropäische Virtual Hub (pEVH), der im Rahmen des europäischen Projekts ENERGIC-OD entwickelt wurde, vereinfacht die Nutzung von offenen Geodaten für alle Nutzer und insbesondere für KMUs. Er ist ein zentraler Zugangsknoten zu einer Vielzahl von Datensätzen. Er verbindet große Open-Data-Plattformen und bietet darüber hinaus Mehrwerte wie etwa die semantische Erkennung für mehrsprachige Metadaten und eine Datenformat-Harmonisierung. Die pEVH-Dienste sind über ein von der ESA entwickeltes Geoportal sowie über Standarddienste und für Entwickler über dedizierte APIs zugänglich. Die grundlegenden Funktionen des pEVH werden allen Benutzern kostenlos zur Verfügung stehen, wohingegen einige Premium-Funktionen für eine geringe Gebühr zugänglich sind. Der pEVH wird mindestens bis zum Ende des Jahres 2020 betrieben und soll die Lücke bei nachhaltigen Geschäftsmodellen rund um Open Data schließen und forschungsgetriebene Projektergebnisse auf den Markt bringen.

Keywords: Open Data, Virtual Hub, Interoperability, Big Data (Variety), Brokered Architecture, Business Model, Space 4.0.

1 Introduction

The ENERGIC-OD technology responds to an urgent market need. While much geospatial data is open, it is not straightforward for innovators to use. The most frequent barriers in the Geospatial Information (GI) data space relate to finding data (59 %) and low data quality (58 %) (Craglia et al. 2010). These are accompanied by problems accessing data (53 %), integrating it (53 %) and cost (48 %). Open government data, in particular, is often difficult to find, hardly interoperable and lacking a standardised open license. In the context of open data, Germany, for example, has developed its own license, the so called "Datenlizenz Deutschland" (www.govdata.de/lizenzen), which does not fully match the license of Open Street Map – OSM. Vickery (2011) notes that improved and cheaper access to higher quality data would lead to the development of greater quality and better market-matched works, based on GI data. In relation to the development of geospatial applications (i. e. data-using software), several additional barriers hinder the effective use of geospatial open data by app developers. Low discoverability, accessibility and interoperability are the most important ones. Finally, big data challenges have an increasing impact on open data usage, especially when Earth Observation and crowdsourcing/Internet-of-Things are concerned, due to big data volumes, large number of datasets or extreme variety of data models and formats (Nativi et al. 2015).

In the present Web era, geospatial datasets are provided online by many existing platforms and infrastructures, including: the INSPIRE (INSPIRE 2017) compliant spatial data infrastructures and systems, the Global Earth Observation System of Systems – GEOSS (GEO 2017), the Copernicus service platforms (Copernicus Services 2017) and the upcoming Copernicus Data and Information Access Services – DIAS infrastructures (Copernicus Team 2017), the numerous crowdsourcing and sensor dedicated platforms, the many open data repositories. Considering the variety of geospatial information types, and for historical and technological reasons, they implement different specifications for interfaces, metadata and data model. In addition, they are often too complex for those developers who are not experts in geospatial technologies. This means that a Web or mobile app developer, who wants to use geospatial data even for simple uses like interacting with a map, needs to spend a significant time exploring different data sources for relevant datasets, learning how to access those datasets, and finally transforming them for adapting heterogeneous data formats, resolutions, coordinate reference systems to his/her app requirements. Existing solutions do not provide a complete framework to lower these entry barriers for developers.

Breaking down these barriers would enable the European economy to unlock the potential for GI data and enable app developers, as well as other stakeholders, to realise data-driven innovations. This is important to

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support the European Single Digital Market strategy (European Commission 2017), the Space 4.0 evolution recently launched by ESA (ESA 2017), and the analogous Industry 4.0 industrial revolution (i-SCOOP 2017). The innovative approach of the pan-European Virtual Hub (pEVH) will directly facilitate the development of new products and services based on the exploitation of (open) GI data. The Web of Data or Web 3.0 revolution is underpinning a single data market where data facilitators and/or brokers, such as the pEVH, are going to play an important role. In such a market, data business ecosystems can create value in a participative way, by providing the know-how, expertise, and knowledge of its participating organizations (Immonen et al. 2014). Providing brokering services and lowering GI data entry barriers, the pEVH can make a geospatial data ecosystem more inclusive. This allows a greater involvement of practitioners and industry members who will be able to bring valuable knowledge and know-how in the ecosystem. The final result is an enhancement of the market value of the open geospatial data ecosystem. The unique selling point of the pEVH is its positioning as a consistent single point-of-access to data provided by multiple sources in many different ways. Through the pEVH, a developer can find datasets (which were originally published by heterogeneous sources) and immediately use them for developing an application, by leveraging the pEVH brokering and transformation functions and APIs.

2 The ENERGIC-OD project

ENERGIC-OD (European NEtwork for Redistributing Geospatial Information to user Communities – Open Data) is a project co-funded by the European Union under the ICT Policy Support Programme in the Competitiveness and Innovation framework Programme (CIP), as a response to a call to "facilitate the use of open (freely available) geographic data from different sources for the creation of innovative applications and services through the creation of Virtual Hubs" – see the project website www.energic-od.eu. ENERGIC-OD designed and developed a Virtual Hub platform integrating existing and mature technologies for data brokering, crowdsourcing and sensor networks. Through the Virtual Hub, end-users can search for relevant datasets using the Virtual Hub Portal, while developers can create new mobile and desktop application using the Virtual Hub APIs (Mazzetti et al. 2015). ENERGIC-OD deployed and manages a pan-European Virtual Hub providing access to datasets from several Open Data platforms under the URL www.vh.energic-od.eu.

On the high level, the pEVH is used by stakeholders interested in developing GIS data-using applications. In order to ensure the uptake of the pEVH use by those stakeholders, the project has developed a Community Involvement plan and undertaken an analysis of user group needs and interests. The consortium partners have also developed an implementable business model for the ENERGIC-OD's main output: the pan-European VH.

In the ENERGIC-OD business model, the pEVH is a modular, marginal cost-charging, brokering platform connecting two sides of a market – GI data users with GI data providers. The freemium monetization model of ENERGIC-OD relies on the provision of GIS data for free to all users, and then charging for some premium functionalities of the pEVH platform to the paying users, such as connection of sensor networks or crowdsourcing data provision. Another option for premium accounts is that Depending on pEVH popularity, data might be offered in limited volume (due to back-end server charges imposed on the ENERGIC-OD consortium by Amazon Web Services) to the free users. For silver and gold users, these limitations will be reduced or lifted entirely, thus differentiating premium levels of pEVH use also by performance (e. g., by implementing limitations on connections or download size). Nevertheless, for the time being (September 2017), no performance restrictions are placed on pEVH. This freemium model helps ENERGIC-OD to penetrate the complex European GI data landscape, securing an initial target of 2 % geospatial data-brokering market share in Europe (before the end of year 2020). At the same time, the consortium partners are making sure that ENERGIC-OD is easy and low-risk for SMEs and similar organizations to adopt (due to low capital expenditure required to start using pEVH as an application developer).

From the perspective of data providers, the pEVH will enable them to make their data more easily discoverable and reusable. For those who sell their data or sell services associated with their data, this will offer them the opportunity to increase their visibility and market share. From the perspective of data users, the pEVH will offer an affordable opportunity to discover, access and effectively and efficiently utilise GI data from multiple, heterogeneous sources by making the data interoperable. As such, the pEVH addresses all of the barriers associated with the use of GI data by developers including barriers around discovery, access, data quality, data integration and cost. Specifically, the combination of these services will decrease the amount of resources required to identify and link different data sets and integrate them into a new application.

3 Virtual Hub technology and European Virtual Hub

The Virtual Hub technology and why we used the brokering approach

The pEVH offers a collection of services that in combination represent a unique and essential configuration that enables data providers and data users to use GI data more effectively.

Cataloguing services – The pEVH catalogues all of the available data accessible through the Hub, including providing data descriptions, metadata, etc. that make the data more discoverable by customers and enable customers to quickly identify relevant data.

Brokering service – The pEVH mediates among heterogeneous data systems, using a brokering approach to access datasets from different providers and make them interoperable as far as possible. This has a positive impact on the quality of the data and the ability of customers to utilise multiple data sets to create applications.

Data harmonization – The pEVH acts as a single point of access to GI data harmonizing datasets from major and smaller providers in multiple formats making them more discoverable and accessible for data users.

Web crawler – The pEVH utilises the web crawler to automatically and methodically search for new GI open data sources, making them available through the portal and APIs.

Crowdsourcing component – This allows pEVH users to create new data. The authentication and login service is provided by LDAP (Light Directory Access Protocol). Crowdsourcing is made possible through SOS (Sensor Observation Services) which send sensor data from the mobile app to an open source platform specialised in receiving and interpreting geospatial data.

Sensor platform – This is a data connector which provides sensors' data measuring physical phenomena (temperature, wind intensity, water pressure, etc.) making it available in several forms, i.e., as OGC web services (WFS, WMS, SOS), as open data brokered by the pEVH's technology or as data visualisations.

The pan-European Virtual Hub and how it can be used/accessed

The consortium has already seen a lot of interest in the pEVH, with over 100 customers already using the platform. With the end of the project and transforming ENERGIC-OD dissemination into targeted marketing and sales activities, the customer numbers are expected to steadily increase, up to 1250 customers in the year 2020. The post-project consortium continues to use marketing and sales activities to communicate the pEVH message to the key customer segments (universities, research institutions, public authorities, non-governmental organisations and SMEs) through existing networks and professional contacts, as well as amplification events (e.g., trade shows such as GEO Business 2017 in London, or INTERGEO 2017 in Berlin).

One of the key differentiators of the ENERGIC-OD pEVH from competing catalogue services is its affordability. ENERGIC-OD partners have decided to use a cost-recovery, freemium business model where only the minimal charges from data users will be collected to cover the cost of updating, maintaining and expanding the pEVH. The pEVH has three levels of customers: free (all stakeholders will be able to access the pEVH's basic data brokering functionality free of charge), silver (allowing uploading customers' own datasets to the pEVH, thus creating more advanced applications), and gold (allowing full access to all pEVH components and services, including crowdsourcing and sensor platform modules). This strategy is geared to stay true to the open data ethos of ENERGIC-OD, boosting its popularity and adoption in the market, while at the same time allowing for revenue streams, thus ensuring the business sustainability of the platform in its post-project exploitation. On the backend, the pEVH will mimic the Amazon Web Services pricing model, where the server charges are based on the actual data use. Such elastic and overall frugal pricing will lower entry barriers for small organisations and SMEs, who are the main target audiences for pEVH.

The freemium model matches the key users of pEVH-brokered data: SMEs (Ladstätter 2015). These stake-holders usually have scarce financial means. Free access to the pEVH-brokered data allows them to benefit from ENERGIC-OD at low cost and risk (i.e., SMEs do not have to commit to technology before knowing the value-added from it to their business, and don't need to cover any up-front costs). Once the revenues of these SMEs increase through the use of pEVH, they can pay for the premium services of the pEVH on either the silver of gold level. As such, offering the pEVH-brokered data to users free of charge promotes the adoption of ENERGIC-OD and increases the value of the pEVH.

A freemium model is best at spurring the development of applications based on pEVH-brokered data. Freemium ensures a fair distribution of the revenues between the ENERGIC-OD consortium and the pEVH customers, which contributes to a long-term increase in the number of apps developed via pEVH platform. Applications, in turn, represent not only the proof of the current value of pEVH-brokered data, but, if commercially successful, they can drive further technological developments and business opportunities for the VH's technology.

4 Applications

The ENERGIC-OD consortium developed 10 mobile/desktop applications using Open Data (see Tab. 1). They are self-contained outcomes of the project with their own market exploitation, but also test the effectiveness and efficacy of the Virtual Hub technology. For this second objective, they were selected to address different application domains (biodiversity, e-government, crowdsourcing, etc.), different application models (data provision applications vs. data usage applications), different application targets and business models (commercial applications vs. free applications).

Two of these applications will be described in detail here, to illustrate the variety of the developed apps and their main goals.

4.1 Detecting noise pollution with NoiseCapture

Noise pollution has a real and negative effect on human health and stands for a burning issue in terms of environment, especially for stakeholders such as public local authorities. To fight against this problem, the European Environmental Noise directive 2002/49/EC tends to *"define a common approach intended to avoid, prevent or reduce on a prioritised basis the harmful effects, including annoyance, due to the exposure to environmental noise"*. To do so, cities of more than 100,000 inhabitants are required to produce noise maps in order to quantify noise pollution, to propose action plans to reduce noise and finally to communicate with citizens. These noise maps are usually produced thanks to data that are mainly coming from reference sensors that are very expensive and available in a small quantity.

Tab. 1: The 10 different applications developed in the project

	Main Application Domain	Application Model
Zaragoza Historical Maps	Tourism	Data usage
eye2eye	e-Government	Data usage
Coastline Monitoring Application	Geology	Data usage and provision (crowdsourcing)
OnoMaP	Environment	Data provision (crowdsourcing)
ProxiSanté	Health	Data usage
Natural hazard assessment for agriculture	Disasters	Data usage
Biodiversity Bird Indicator	Biodiversity	Data usage
GeoPan Atl@s	Geology	Data usage
geoDEMOS	e-Government	Data usage
Sensor Open Data Portal	Monitoring	Data provision (sensor networks)

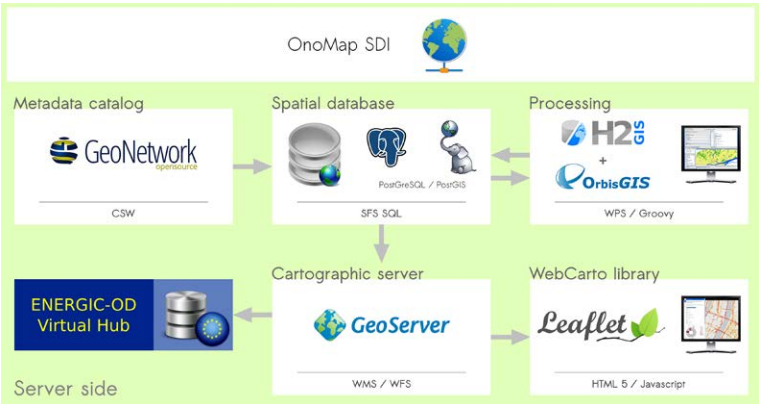

Fig. 1: The OnoMap architecture

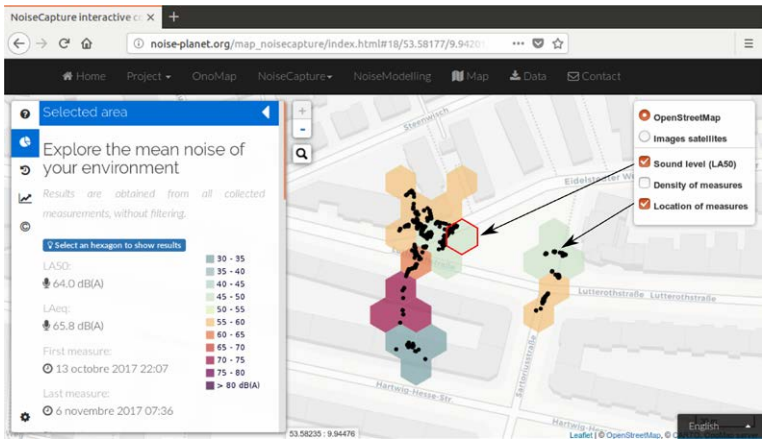

Fig. 2: Online noise map with contributions from NoiseCapture users, in the suburbs of Hamburg (Germany)

In this context, tools developed within ENERGIC-OD by CNRS Lab-STICC and IFSTTAR partners aimed to develop a participative approach based on collaborative noise maps produced thanks to smartphones (i. e. from citizens) for a massive acquisition of noise data in urban or suburban areas. All these developments take place in an innovative platform named Noise-Planet.

4.1.1 Noise-Planet, OnoMap and NoiseCapture

Noise-Planet (http://noise-planet.org) is a project, which aims to provide a global and generic framework dedicated to collection, modelling and assessment of environmental noise measures. One of the central components of this project is the OnoMap ("Open noise Map") Spatial Data Infrastructure (SDI) (Bocher et al. 2016, Guillaume et al. 2016, Picaut et al. 2017). This platform collects, organizes, describes, analyses and shares noise data (mainly coming from the NoiseCapture app for the moment). Based on open-source software, fully compliant with the INSPIRE Directive as well as both common and standardized languages and encoding from OGC (e. g. WMS, WFS, SFS ...), this SDI is able to interact with other SDI – including the ENERGIC-OD pEVH (see Fig. 1).

NoiseCapture (http://noise-planet.org/noisecapture.html) is a free and open-source Android app allowing users to measure the noise in their environment. Thanks to the smartphone's GPS, each measure is geolocalized/georeferenced on a map (available on the app or online http://noise-planet.org/map_noisecapture/index.html (see Fig. 2)). Once the measurement is complete, the user is invited to add description such as the pleasantness rating, the conditions of the measurement and the type of noise sources. Then, data are uploaded to the OnoMap SDI in order to be stored, cleaned, processed and finally freely provided thanks the following two forms:

- as raw .geojson files, packaged every night in one .zip file per country, and delivered under

ODbL licence (free to use) at the address http://data.noise-planet.org, (Bocher et al. 2017),
- as WMS/WFS streams, consultable in a dedicated interactive web map, accessible at http://noise-planet.org/map.html.

NoiseCapture and OnoMap have demonstrated their ability to respectively produce and manage huge noise datasets coming from different countries in the world, including Europe. In the mid-October 2017, NoiseCapture contributions represent more or less 2,500,000 points of measures, 13,500 tracks, 77 countries and 100 mb of raw data (as .zip files).

4.1.2 The benefits of the pEVH

The OnoMap SDI has been connected to the pEVH in order to disseminate NoiseCapture resulting data more widely. Thanks to its discovering and brokering services, the pEVH is able to provide to its users (developers and data consumers) an up-to-date list of all measures made by the NoiseCapture community. In the meantime, the pEVH services are used to search and consume open-data (e. g. population census), useful to evaluate the noise exposure of inhabitants.

4.2 With eye2eye to new procedures of citizens' participation

eye2eye, as one of the apps developed in the project, improves the information exchange between citizens and the administration by means of a mobile information and communication solution for the land consolidation process based on the "LandEntwicklungsFachInformationsSystem" (LEFIS). eye2eye brings added value to the already existing desktop solution also developed by AED-SICAD AG. The goal is to shorten long processing times and to optimize citizen participation in the land consolidation projects. These projects typically last several years and are characterized by a high interest from the involved citizens.

A land consolidation process has two phases. In the first phase, the so-called preliminary procedure, there is a wide citizen's participation in order to reach acceptance and to detect whom a planning process might affect. The follow up process is a closed and strictly regulated management in a community of affected land owners. eye2eye will focus on the first phase for public citizen's information.

eye2eye serves as a tool for brainstorming and discussion using georeferenced comments based on a map-based application. The app thus complements the traditional methods of classical participation. It provides an overview of the planning status at all times and above all in the field and prevents unauthorized access to personal or sensitive data via a granular legal control. Geo-information from Copernicus, INSPIRE and Open Data sources supplement a basic map as required. This is one of the most important features of the app to support a better description of the current situation. This information is found by a free text search and/or a spatial reference to a marked area. The search criteria are passed to the Virtual Hub and the result data is then integrated in the app using the API of the Virtual Hub to access the brokered data sources.

Furthermore, the citizens have the option to comment or discuss with the administration and other parties. The involvement of other citizens (not only landowners) may arise in land consolidation processes for environmental or energy reasons (wind energy, solar energy ...). Citizens and affected owners are thereby supported in the preparation (pre-litigation) or participation in a formal land consolidation process.

The app is developed in HTML5 and is designed as a mobile, map-based web app, which adapts to any client using responsive design. The technical architecture combines free access to GI as well as limited access for authorized users by a role management system. The app manages the ongoing permanent flow of restricted data resources to open data sources by his resource management system.

The following functionalities are combined in eye2eye:
1. As a web map app, eye2eye allows easy navigation in maps.
2. Users can request information about objects from the maps.
3. Entering georeferenced text notices allows users to participate directly in the process (see Fig. 3).
4. "Likes" make it easy to comment on plans.
5. Drawing in the map is available as an optional function.

The citizen thus has the possibility of directly commenting or exchanging with the administration and other stakeholders independently of fixed participant meetings. With this eye2eye promotes and enhances transparency

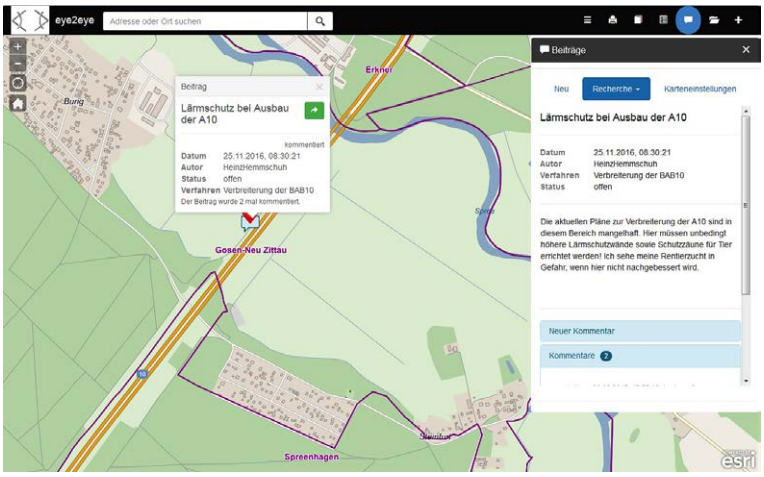

Fig. 3: Georeferenced text notices in eye2eye

and agility in the land consolidation process and offers new possibilities for mobile information and participation. The common view on a wide range of geo-information and localized contributions can improve the quality and timeliness of the information processes. Citizens on the one hand receive participation possibilities that are more active, whereas the administration on the other hand benefits from increased responsiveness and an intensified dialogue to access new ideas and information about requirements of landowners and other users.

5 Outlook

The pEVH addresses issues related to access to and use of geospatial open data by developers who are not necessarily expert in geospatial data and technologies. The pEVH acts as a consistent single point-of-access to data provided by multiple heterogeneous sources. pEVH exposes a set of APIs that provide harmonised discovery and access to datasets published by heterogeneous systems. Those capabilities make the pEVH a unique solution for facilitating the use of geospatial open data, lowering the existing entry barriers for developers, and allowing them to focus on the business logic of their application, reducing the time-to-market with a great benefit in terms of market and job opportunities. The variety of applications developed by exploiting the pEVH capabilities demonstrates the validity of the brokering and mediation approach and its effective and efficient implementation in the ENERGIC-OD project. Moreover, the pEVH solution is a flexible framework: the capabilities of the Virtual Hub can be improved over time with new common functionalities, including more semantics services and processing, assuring scalability and the platform's ability to evolve in the future to meet changing users' and market needs.

To the ENERGIC-OD target market (SMEs, universities, local governments/authorities, non-governmental organisations), pEVH can mean greater availability of GI data to be used without the need to come up with in-house software (which is expensive, time-consuming to make and resource-intensive). The users can find new data applications, link new types and sources of data together, at the same time doing it with relative ease and focusing on the marketing of their application.

A Freemium-focused business model was introduced for the pEVH platform. This model will ensure its functioning and sustainability in the medium and long term; it also means that the pEVH is easy to pick up even for stakeholders with very limited resources (such as start-ups for instance, or independent researchers). Freemium business models are widely used by market entrants and established players alike in the ICT industries (and in particular for software services functioning as data or information brokers). The consortium expects the successful capturing of revenue by freemium model also in the case of ENERGIC-OD.

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