Invitation to tender

Sensordata – testbed description and research topics

Geonovum

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Friday November 1st	First draft
Monday December 16, 2024	Added RIVM requirements for SOS
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Chapter 1 - Introduction

This chapter gives the general background to the testbed Geonovum is organizing and specifies its goals and scope.

Invitation to tender

This document gives information about the invitation to tender regarding the following three research topics:

- Research topic #1: **Communicating with a collection of sensors**
- Research topic #2: **Visualisation & analysis**
- Research topic #3: **Initial device registration**

For each research topic a budget of € 12.500 excluding 21% VAT is available (see chapter 9).

Background

Sensordata is becoming increasingly important in the Dutch public sector. Smart cities initiatives, citizen science projects as well as nationwide sensor networks for specific tasks (e.g. environmental monitoring) have been increasing the amount of sensordata available. Being able to make sense of this data and combining data from diverse source in applications such as digital twins is increasing the need to standardize sensordata.

Goal of the testbed

We want to explore how standards for sensors can help the public sector better organize and leverage their available sensordata.
We want to address these questions based upon typical use cases and user questions we have identified.

Geonovum, in line with its mission, is keen to get the answers; and it seeks to involve the market to do so. The actual questions and issues to be addressed are described in this document, combined into three research topics.

Scope

In this testbed we are looking at implementing standards that apply to sensordata such as sensorthings API, connected systems API. We have two use cases including sensordata that can be used available to help anwser the questions.

Outcome

The results of the testbed are intended to contribute to expand and innovate the Dutch public sector Spatial Data Infrastructure in a direction that takes into account the possibilities in the market today. Based on the outcome of this testbed we may take steps to make one or more sensor related standards mandatory within the Dutch public sector, in order to promote interoperability between sensor networks and encourage reuse.

To this end implementations of standards realized within this testbed will be kept online and available for further experimentations for 6 months after the testbed ends.

This document

After this introduction, chapter 2 explains the tender procedure. Chapter 3 provides a detailed description of available use cases. Chapter 4 introduces the three research topics. Chapters 5 through 7 describe the

research topics in detail. Chapter 8 explains the organization of the testbed in more detail. Appendix A gives the metrics by which proposals are judged.

This document is a draft. Based on questions and comments during and after the tender period we will update this document to clarify questions and remove errors. A final draft will be made available within one week of the question period ending.

Chapter 2 - How to tender

This chapter gives the information about the procedure of tender response.

Rules and procedure

The submission period for the tender starts on January 9th, 2025 with the publication of the Invitation to Tender on Geonovum's website, www.geonovum.nl.

The tender is open to private and public parties, and to combinations of parties (consortia). In the case of a consortium, there is one party who acts as the contact point and contractor on behalf of the consortium for the tender with Geonovum.

Questions about the tender can only be asked by sending an e-mail to info@geonovum.nl, addressed to Frank Terpstra, coordinator of the testbed. Questions should be submitted by Thursday January 23rd. These questions and our answers are collected in an Information Note. We will organize an informational meeting on Wednesday, January 22nd at 16:30h. The minutes of this meeting will be part of the Information Note. At the latest, this note is published on the website of Geonovum on Monday, January 27th.

Your tender must be submitted by sending an e-mail to info@geonovum.nl, addressed to Friso Penninga, director of Geonovum.

The tender is preferably written in English[1] and must at least contain:

- The research topic or topics you are applying for;
- Motivation for the research topic or – topics you are applying for;
- Plan of approach for each addressed research topic (maximum of four pages per research topic);
- References (including e.g. publications, projects, blogs, code on GitHub) and curriculum vitae for performers of the research, showing enough relevant knowledge and experience;
- An indication of the in-kind investment;
- Statement of agreement with the publication of the research results and deliverables under a CC/by license.

All outcome will be available under http://creativecommons.org/licenses/by/4.0/. Deliverables of the research topics, in the form of published data, vocabularies, demonstrators, prototypes and the like, must remain available for at least six months after completion of the testbed.

All source code is preferably available under a "popular and widely used or with strong communities" open source license as identified by the open source initiative. The use of other (non-opensource) licenses will be considered only if well motivated.

The deadline for submitting a tender is Friday, February 7th, 2025.

Geonovum will judge the received tenders in the second week of February (feb 10th-14th), according to the criteria stated in appendix A.

Parties are allowed to tender for more than one research topic. However, a contractor is only awarded one research topic, not several. The reason for this is our wish to gain different insights by different parties. The only exception to this rule is that additional research topics can be awarded to a single party if this party is the only bidder for an additional topic. We will only do this if the bidder agrees.

Geonovum will announce which party is selected for which research topic on February 14th at the latest. All parties who have submitted a tender will be informed about this via e-mail.

Note that reviewers of this document and Geonovum staff[2] are exempt from bidding.

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[1] The alternative is Dutch

[2] Employees and Secondments

Chapter 3 - Use cases

This chapter describes use cases that can be employed within the testbed. These are provided as inspiration, you are free to re-use them but can also provide your own. The first phase of testbed execution will leave room to make detailed plans on interaction between research topics.

Use case #1: RIVM air quality

Use case #1A
RIVM has the obligation, according to the EU legislation INSPIRE, to deliver the hourly air quality data for specific depositions. This data is generated out of the AQ database on a hourly basis, harvested with a python script and saved on the specific SOS inspire webserver. (https://inspire.rivm.nl/sos/eaq/#map)

The SOS software was created by https://52north.org/ as a tool for ArcGIS Server and adapted for the RIVM to operate on a Apache Tomcat instance as Open Source Software tool (https://github.com/52North/SOS/). Since the implementation of the software in 2013 this software has never been down except for maintenance.

To be future proof as an organization and to comply to the newer Open Standards available, we as RIVM would like to investigate the options, possibilities and risks to replace their SOS instance with a OGC SensorThings API standard, OGC connected systems API or even better an Observations Measurements and Sampling (OMS) solution.

Use case #1B
In an effort to support citizen science in The Netherlands, RIVM also hosts the 'Samen Meten' platform: a data infrastructure that brings together official hourly air quality measurements and sensor-based civil measurements of local air quality. These sensor data are currently made available to the public through a STA v1.0 API server (https://api-samenmeten.rivm.nl/v1.0). A brief introduction to this service may be found at one of the following two webpages:

- English: https://www.samenmeten.nl/international/API
- Dutch: https://www.samenmeten.nl/dataportaal/api-application-programming-interface

We offer this service as an example of how a STA can be used in practice and as a dataset to query or import as part of this testbed. Further, we would like to investigate how this API service could be improved to provide better metadata, for instance through an implementation of the STAplus extension (https://docs.ogc.org/is/22-022r1/22-022r1.html) or an exploration of appropriate metadata standards.

Use case #2 Municipality of Rotterdam

The municipality of Rotterdam has a multitude of sensors transmitting on LoRa via chirpstack that produce raw JSON. These sensors measure groundwater levels, soil moisture, soil Ph and temperature, water leakage and in addition there are people counting sensors and 12-1 weather stations(that measure 12 weather related parameters). These are documented in more detail (including example JSON) in an attachment provided with this invitation to tender.
They would like to gain experience in having these sensors exposed through interoperable standards such as Sensorthings API or connected systems API.

Chapter 4 - The research topics

This chapter describes the research topics that are part of the testbed. Each topic is described in more detail in the following chapters.

Introduction to the research topics

The research topics, although overlapping in scope, are specifically chosen to address different leading perspectives and goals. Below these are spelled out, for each of the three research topics.

Research topic #1: Communicating with a collection of sensors

Research topic #2: Visualisation & analysis

Research topic #3: Initial device registration

Chapter 5 - Research topic #1: Communicating with a collection of sensors

Goal

There are many use cases where one type of sensor is placed in many locations. There is great utility in querying all of these sensors at the same time with one simple operation. For example "give me all current temperature readings from the collection of temperature sensors in the municipality of Rotterdam". We want to know how this can be achieved using different OGC API standards and what the benefits and negatives for each standard are in practice.

Description

The latest version of the OGC sensorthings API standard: STA-plus supports collections, but not explicitly the ObservationCollection as defined in the Observations Measurements and Sampling (OMS) model. Another approach could be to use the new OGC connected systems API: a broader standard that can also be applied to sensordata. Connected Systems does not explicitly support OMS ObservationCollection either.

Task

We would like to see a comparison between the two approaches by implementing both standards in a proof of concept implementation. We would also like to know how both approaches support OMS ObservationsCollection and if additions to these standards for better support are needed or if they support this well "as is".

Deliverables

- A written report, Geonovum will provide a github repository where the report can be added in markdown format. We will act as editors and consolidate all reports into one Respec/HTML document.
- If any software is developed this should be made available in an opensource repository and as pull requests to existing OS projects in case these are used
- A server running the PoC should be kept available for the public at least until 6 months after the testbed ends.

Requirements / standards / Open Source software

Mandatory Standards:
OGC sensorthings API standard
Observations Measurements and Sampling (OMS)
OGC connected systems API

Optional available Open Source Software:
For sensorthings API an opensource client and server implementation is available:
https://github.com/FraunhoferIOSB/FROST-Python-Client
https://github.com/FraunhoferIOSB/FROST-Server
https://github.com/securedimensions/FROST-Server-PLUS

For Connected systems API there are two opensource server implementations in development:
https://github.com/opensensorhub/
https://github.com/52North/pygeoapi/tree/feature/connected-systems
As well as open source client libraries in development:
https://github.com/opensensorhub/
https://github.com/opensensorhub/osh-js

https://owslib.readthedocs.io/en/latest/usage.html#ogc-api-connected-systems-part-1-feature-resources-part-2-dynamic-data

Above software is listed for convenience, there may be more available. The use of open source software is preferred but not mandatory.

Relevant use cases

Use case #1A RIVM
RIVM has the obligation, according to the EU legislation INSPIRE, to deliver the hourly AQ data for specific depositions. This data is generated out of the AQ database on a hourly basis, harvested with a python script and saved on the specific SOS inspire webserver. (https://inspire.rivm.nl/sos/eaq/#map)

The SOS software was created by https://52north.org/ as a tool for ArcGIS Server and adapted for the RIVM to operate on a Apache Tomcat instance as Open Source Software tool (https://github.com/52North/SOS/). Since the implementation of the software in 2013 this software has never been down except for maintenance.

To be future proof as an organization and to comply to the newer Open Standards available, RIVM would like to investigate the options, possibilities and risks to replace their SOS instance with a OGC SensorThings API standard, OGC connected systems API or even better an Observations Measurements and Sampling (OMS) solution.

Use case #2 municipality of Rotterdam
The municipality would like to see their live sensordata exposed using standards such as Sensorthings API and connected systems API and learn what this would mean in practice. For instance how would groundwater levels, which are derived by calculation from the raw sensordata, be exposed. How would sensors that measure multiple values (12-1 weather station) be represented. Can the sensors benefit from being exposed in an Observations Measurements and Sampling (OMS) solution.

Chapter 6 - Research topic #2: Visualisation & analysis

Goal

An important aspect of working with sensor data is, of course, being able to get the data and load it into an application for visualisation and analysis. This research question is about demonstrating that this works, both in a web viewer and in a dashboard application (e.g. Grafana).

Description

A web application in the context of this research question is a web-based environment, running in a web browser, that lets a user find and view sensor data. A dashboard application in this context is an application not only for finding and viewing sensor data, but also for analytics, querying, alerts, etc. We have no restrictions on this being a browser application or a desktop application.

Task

Demonstrate the following steps in both types of application:

1. The user searches for and finds different sensors that offer sensor data;
2. The users selects a subset of measurements based on several criteria. The following criteria must be demonstrated as a minimum:
   a. most recent measurement of one sensor;
   b. all measurements at a certain location within a certain time period;
   c. most recent measurement of a selection of sensors that are located within a bounding box.
3. The application loads the selected measurements;
4. The user can view and use the measurements within the application.

Deliverables

- A written report; Geonovum will provide a Github repository where the report can be added in markdown format. We will act as editors an consolidate all reports into one Respec/HTML document.
- If any software is developed this should be made available in an open source repository and as pull requests to existing OS projects in case these are used.
- A server running the PoC should be kept available for the public at least until 6 months after the testbed ends.

Requirements / standards / Open Source Software

Mandatory Standards:
OGC sensorthings API standard

Optional available Open Source Software:

- FROST-Client is a Java client library for communicating with a SensorThings API compatible server.
- Geodan SensorThings .NET SDK makes it easy to add OGC SensorThings support to your .NET application.
- Grafana is an open source dashboard application for sensor data.

Above software is listed for convenience, there may be more available. The use of open source software is preferred but not mandatory.

Relevant use cases

The sensor data is made available via an OGC SensorThings API endpoint see use cases below. In addition there are other public end points and it is allowed to set up your own end points to use within the testbed.

Use case #1B RIVM

RIVM offers an existing STA endpoint (https://api-samenmeten.rivm.nl/v1.0) with can serve input for analysis and visualization demonstrations. Further, we are interested to investigate if this endpoint offers sufficient data and metadata detail to support connections to third party dashboards, or if (small) tweaks are required in order to enable easier integration of the offered data with other tools.

Chapter 7 - Research topic #3: Initial device registration

Goal

Initial device (aka Thing) registration in a system is not well documented or standardized and hinders uniformization and encourages bespoke solutions.
'Things' are made in the factory by the thousands, all with the same firmware specified by the manufacturer. The Things have several sensors (possibly different ones) on - board that will measure values. When the thing is first turned on, it will try to connect to a service (over eg a LoRaWAN Network or the internet over a 3G network) specified in the firmware.
When this connection is established, the thing must register itself with that service. The thing 'comes ashore' for the first time.

Description

A SensorThingsAPI (STAPI) service may already know the thing and its sensors because it is provided by the manufacturer – or it may not. Most Things are made for a proprietary service, which is not STAPI. That proprietary service knows (or does not) which things are allowed to come ashore and under what identity.
Things can uniquely identify themselves – via the SIM IMEA or CPU identifier. But how can a thing/sensor that is not made for STAPI – still send relevant data to the STAPI service? To do this, a DataStream identifier is needed. Who provides this of how is it made available to the Thing?

Task

Show how to register a new sensor/data stream within your sensor system. There seem to be hardly any standards or best practices for this. Every sensor manufacturer does it in their own way. How do you find the sensor the first time, it is new from the factory with standard firmware, how does the sensor know how to connect? Do you first have to connect it to a computer with USB/Bluetooth and configure it? Or can it find a network itself and is it accessible there in a standard way?

Deliverables

- A report: short document describing the 'coming ashore' procedure and what data is exchanged
- If any software is developed this should be made available in an open source repository and as pull requests to existing OS projects in case these are used.
- A server running the PoC should be kept available for the public at least until 6 months after the testbed ends.

Requirements / standards / Open Source Software

Mandatory Standards:
OGC sensorthings API standard

Optional available Open Source Software:
For sensorthings API an opensource client and server implementation is available:
https://github.com/FraunhoferIOSB/FROST-Python-Client
https://github.com/FraunhoferIOSB/FROST-Server

Above software is listed for convenience, there may be more available. The use of open source software is preferred but not mandatory.

Relevant use cases

Chapter 8 - Testbed organization

This chapter describes the organization, conditions, finances and planning of the testbed.

Coordination

The coordinator on Geonovum side is Frank Terpstra (Geonovum), with support roles for:

- Linda van den Brink (Geonovum)
- Bart de Lathouwer (Geonovum)

For every research topic there is a bi-weekly meeting between Geonovum and each contractor, either at the Geonovum office in Amersfoort or online. The agenda items of these meetings are the progress and any issues or technical questions concerning the details of the research topic.

Open testbed sessions

Work on the three research topics will be carried out in parallel. During this time, Geonovum wants the three research topics to inform each other as much as possible. For this reason, Geonovum will organize three sessions (max. 1/2 day each) with the contractors of all three research topics. This will be done for the purpose of aligning and sharing developments and knowledge between the research topics.

These sessions will be public; the contractors will present their intermediate results to each other and an open group. Anyone who is interested can be present at these meetings. This group has the possibility to discuss in an open way the results with the contractors. The insights gained from this will be used as much as possible by the contractors in their further work on the research topics.

In addition to these meetings, Geonovum will organize a larger public session after completion of the testbed, in which the contractors have the opportunity to present their final results.

Planning

Geonovum will announce which party is selected for which research topic on Friday February 14th at the latest (see chapter 2). The testbeds starts immediately afterwards, as do the bi-weekly meeting between Geonovum and each contractor.

The open testbed sessions with contractors will take place in the middle of February, March and April.

In February we will focus on synergy between the contractors and the use case they implement. March will focus on realization and in April the focus will be on reporting results.

The deadline for carrying out the research topics is April 30th, 2025.

Hereafter a public, open session will be organized in which all results will be presented by the contractors and Geonovum.

Finance

For each of the three research topics a budget of € 12.500 excluding 21% VAT is available.

These budgets are intended as a contribution towards the research activities of the contractor. The budgets allow each contractor to carry out research and exploratory activities and to develop demonstrators to try things out. The budget is not supposed to cover the entire research activities of the contractors; an in-kind contribution of the contractors is expected.

Appendix A: Metrics

The criteria by which proposals are judged are:

- The quality of the plan of approach
- The quality of the references and CVs
- Affinity with data (publication)
- Impact on existing workflow in terms of quality, cost, etc... and general architecture
- Contributions towards EU and NL govt. information services and flows
- Planned dissemination of the created work; documentation and `how to' documents, publication strategy relative to the community, licenses used.

Proposals are judged with two metrics: a general score against the key goals of this document (75%), and a further 25% for key elements specific to each of the three testbeds.

All proposals will be scored according to the following metrics:

		Weight
Overall	Contribute to the "Goal of the testbed"	10%
25%	Applicability to the "Scope" as defined	5%
	Further open standards and interoperability	10%
Architecture	Re-use of provided datasets and endpoints of RIVM and/or the municipality of Rotterdam	10%
20%	Re-useability after testbed ends	10%
Proposal	Plan or approach	10%
30%	Conciseness and specificity of the plan	5%
	Portfolio, References and CV	5%
	Dissemination, Licenses, lasting effect of outreach beyond geo community	10%

A further 25% is awarded for each of the testbeds specific key goals:

Specific	1: Communicating with a collection of sensors	25%
25%	2: Visualisation & analysis	25%
	3: Initial device registration	25%