SMART CITY REFERENCE ARCHITECTURE WHITE PAPER— SUPPLEMENT

GEOSPATIAL DATA INTEROPERABILITY PLATFORM

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Secretariat of the Science, Technology and Innovation Policy,
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CONTENTS

1. INTRODUCTION

1-1. PURPOSE AND SCOPE OF THIS DOCUMENT

While geospatial information has become increasingly important, the integration between City OS platforms with Geographic Information Systems (GIS) has been limited. Services related to disaster prevention, welfare, and urban policymaking adopt different map systems and infrastructure.

To promote the distribution of various geospatial datasets across applications on City OS platforms, it is crucial to clarify data specifications—such as geospatial data content, structure, terminology, quality and format—. while recognizing the foundational role of The Digital Japan Basic Map provided by Geospatial Information Authority of Japan, Ministry of Land, Infrastructure, Transport and Tourism. This clarity enables both data producers and users to correctly understand and apply geospatial data.

Standardization data specifications help prevent creation of overlapping or conflicting specifications.

This document aims to define the specifications for the “GEOSPATIAL DATA INTEROPERABILITY PLATFORM” based on the approach and direction set out in the Smart City Roadmap (Smart City Reference Architecture White Paper, March 29, 2024).

2. ARCHITECTURE

The core objective of this document is to present an architecture that facilitates the integration of various geospatial information by converting them into 'map tiles' and enabling effective data utilization

Delivering geospatial information as map tiles offers several key advantages:

- Reduced Development Costs: Application developers no longer need to perform complex data processing and can begin creating services using preformatted data APIs.
- Expansion of Applications: Apps that utilize standardized data formats can be easily adapted and scaled across different regions and use cases.
- Avoidance of Vendor Lock-In: By adopting open-source specifications, organizations can avoid reliance on a single vendor.
- Compatibility with Spatial IDs: Spatial IDs, promoted by the Ministry of Economy, Trade and Industry, can be integrated with map tiles, enabling usage in AI, robotics, and other advanced applications.

From a server infrastructure perspective, local governments (municipalities) generally need a server to host and distribute map tiles. However, because map tiles can be served as static files that require no database or complex middleware, this approach results in low cost and high availability.

2-1. MAP TILE FORMATS

Three primary formats are considered for map tiles:

RASTER TILE

Tiled map images rendered by server programs. While raster tiles are widely used for distributing satellite imagery, they are not recommended as a basis for data linkage due to their low machine readability.

VECTOR TILE

Geospatial information distributed as data “objects” in the form of tiles. Vector tiles are rendered into visual maps on the client side, offering high machine readability and making the data reusable for various applications, including AI-driven services.

DATA PNG

Data PNG is a method of representing data using the PNG (Portable Network Graphics) image format. It is an effective method for data with gradations—such as meteorological or elevation data— that vector tiles cannot easily handle.

While not technically a map tile, the GeoJSON format is also a widely adopted and highly compatible with Geospatial Data Interoperability Platform.

2-2. RECOMMENDED SDKS AND LIBRARIES

The Geospatial Data Interoperability Platform uses the following open-source libraries to handle tiled geospatial information:

Name	License	Usage
MapLibre GL JS	MIT	JavaScript library for rendering vector tiles as visual maps
deck.gl	MIT	JavaScript library for 3D data visualization
Ouranos Ecosystem	MIT	A library for spatial IDs (promoted by Ministry of Economy, Trade and Industry)

2-3. OVERALL SYSTEM CONFIGURATION

The Geospatial Data Interoperability Platform comprises multiple servers and services that collectively provide three main functions.

DATA LAYER

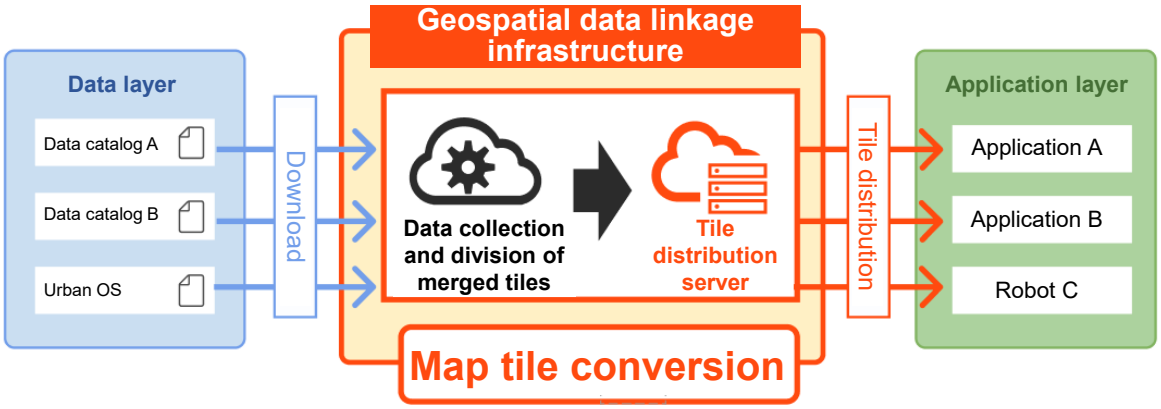
This layer includes systems that collect and store geospatial data, such as City OS platforms, data catalogs, electronic forms. Examples include FIWARE, CKAN, and GitHub repositories, and IoT devices.

GEOSPATIAL DATA INTEROPERABILITY PLATFORM

A suite of systems that aggregate geospatial information from the Data Layer and distribute it as map tiles.

APPLICATION LAYER

This layer consists of applications that utilize data provided by the Geospatial Data Interoperability Platform. Typical examples include disaster prevention and event management applications.



2-4. CORE FUNCTION AND SERVICES

The primary functions required for Geospatial Data Interoperability Platform are as follows:

DATA CONVERSION

Municipalities manage a wide range of geospatial data, which encompasses real-time data from IoT devices (e.g., river sensors) and open data, such as information on AED installation sites.

The Geospatial Data Interoperability Platform must be equipped with a data conversion function to deliver these data as map tiles or through APIs.

This service converts geospatial data in various formats into the following formats to provide visual and machine-readable map tiles:

- **Vector tile**

  This service converts geospatial data in various formats into the following formats to provide visual and machine-readable map tiles.

- https://github.com/mapbox/vector-tile-spec/tree/master/2.1
- https://github.com/madefor/vector-tile-spec/tree/master/2.1 (Japanese)

- **Data PNG**

  Suitable for datasets with continuous gradations, such as elevation or weather data, which are not easily handled by vector tiles. Developed by Japan's National Institute of Advanced Industrial Science and Technology, the Data PNG format is publicly documented here: https://gsj-seamless.jp/labs/datapng/

- **GeoJSON**

  Ideal for smaller datasets such as AED locations or facility information. As a widely adopted format for open data, GeoJSON can be used directly in many existing applications. For large datasets, however, vector tiles are preferable to avoid large file sizes.

MAP TILE SERVER

A server that hosts and delivers map tiles. A simple static file server is recommended.

- **Access log**

  It is strongly recommended to store access logs appropriately in order to monitor usage trends, detect unauthorized access, and manage server load. Most standard web server log formats are sufficient.

- **Access analysis**

  Implementing analytics tools to visualize access logs is also recommended for better operational insights.

2-5. ADOPTION OF OPEN-SOURCE TECHNOLOGIES

When introducing a map system, it is desirable to avoid overreliance on specific technologies or vendors. Therefore, the extensive use of open-source software is strongly recommended.

Open-sourcing newly developed assets also promotes cross-platform compatibility and contributes to sustainable, low-cost maintenance.

3. DATA AND SYSTEMS INTEGRATION

3-1. DATA SOURCES

The Geospatial Interoperability Platform enables the integration of various data sources, including City OS platforms, private corporations, and government agencies.

3-1.1. MUNICIPALITIES

Among the open data held by municipalities, the following data sets are recommended:

- **Standard municipal open data set**
  Geospatial information such as lists of public facilities, defined as part of the municipal standard open data sets by the Digital Agency of Japan.
- **Basic urban planning maps and other urban planning information**
  Urban planning maps that have a foundational role in local government operations.
- **Various registries**
  Registries such as park registries and road registries, which contain geospatial information and can be managed within the Geospatial Data Interoperability Platform.

3-1.2. GOVERNMENTAL OPEN DATA

Japanese ministries and organizations provide various geospatial data, such as the following:

- Base map data from the Geospatial Information Authority of Japan (GSI)
- National land numerical information and real estate information library (Ministry of Land, Infrastructure, Transport and Tourism)
- Other open data distributed in GeoJSON or vector tile formats

3-1.3. PRIVATE SECTORAL DATA

The platform enables the integration of private sectoral data at significantly lower cost than before.

- People flow data
- Meteorological data
- Various geospatial information maintained by private companies

3-1.4. REAL-TIME DATA

The platform can also manage real-time data from municipal telemetry systems, sensors, and road traffic information.

If a City OS is already in place, it is recommended to integrate such data through the existing system.

4. APPENDIX

4-1. Reference information for Project Specification Preparation

4-2. Application example

4-3. Terminologies and definitions

4-1. REFERENCE INFORMATION FOR PROJECT SPECIFICATION PREPARATION

Table of Contents for Project Proposal of "Takamatsu City Geospatial Data Infrastructure (WebAPI) and Application Development" (August 2022, Geolonia Inc. and PwC Consulting LLC)

Agenda

1. Policy for Work Implementation
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   1.2. Work implementation policy and details
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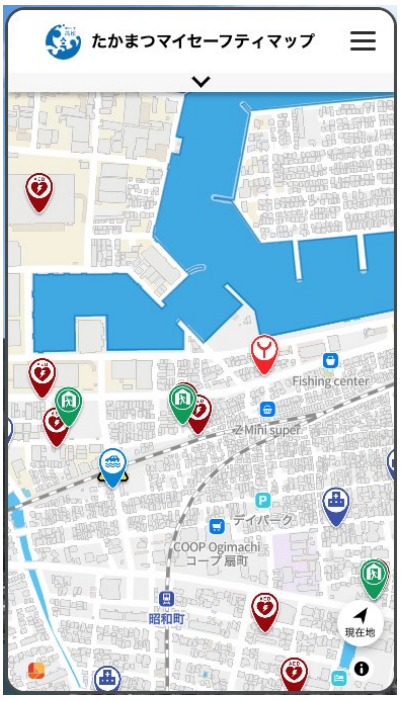
3. Organization Framework for Work Implementation
4. Proposed Schedule for Work Implementation
5. Qualification, Certification, etc.
6. Work Accomplishments

4-2. APPLICATION EXAMPLE

TAKAMATSU MY SAFETY MAP (TAKAMATSU CITY)

This disaster information service for residents leverages maps and datasets provided by the Geospatial Data Interoperability Platform. By tapping on locations such as a home address, school route, or workplace, users can view disaster risk specific to the location. The application also provides real-time sensor data on water levels, tides, flooding, and displays the locations of essential facilities such as evacuation centers, hospitals, AEDs—critical for disaster preparedness and response.

https://safetymap.takamatsu-fact.com/



4-3. TERMINOLOGIES AND DEFINITIONS

API (Application Programming Interface)

A set of definitions and protocols for building and integrating application software.

Attributes/Property

Dataset attached to features such as categories, telephone numbers, and business hours. Typically structured as name–value pairs

Data linkage

The process of enabling systems to share and simultaneously use data across organizational boundaries by implementing APIs, authentication mechanisms, and other integration methods.

Feature

A simplified representation of a real-world object (natural, man-made, or conceptual) within a digital map. Features are typically stored as geometries (points, lines, or polygons) combined with attribute data.

FIWARE

A platform developed for cross-sectoral data utilization by municipalities and private companies, commonly referred to as a City OS.

https://github.com/Fiware

GeoJSON

A format for encoding a variety of geographic data structures.

Geospatial data interoperability platform

A foundational system that integrates geospatial data distributed across different organizations and systems, enabling application development based on shared data resources. It provides services such as data conversion, distribution, visualization, machine-readable formatting, APIs, and SDKs.

Geospatial information/geospatial data

Data that identifies the location and characteristics of features on Earth.

GIS (Geographic Information System)

A system that uses geographical locations as a basis for managing, processing, and visually displaying spatial data, enabling advanced analysis and rapid decision-making.

Interoperability

The ability of a system to seamlessly exchange and use information with other systems.

Mapbox/MapLibre style

A JSON-based document defining the visual styling rules of map data stored in vector tiles.

SDK (Software Development Kit)

A set of development tools, functions, documentation, and test tools that facilitate software development.

Spatial ID

An identifier of geographic location that adds a vertical height index (f) to the standard map tile numbering system (z, x, y). It is promoted by the Ministry of Economy, Trade and Industry and is compatible with the existing web map ecosystem.

Vector tile

A small, pre-formatted unit of geographic data used to render web maps. Vector tiles are similar to raster tiles, but they use vector data instead of raster images.

Writing assistance

Geolonia Inc. PwC Consulting LLC

Contact information

(For more information on geospatial information)

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https://geolonia.com

(For general information on the smart city reference architecture white paper)

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Please see the “Contact Us” section at the bottom of the page.
https://www8.cao.go.jp/cstp/society5_0/smartcity/index.html

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