THE DEVELOPMENT OF WEB-BASED COORDINATE TRANSFORMATION SERVICE OF THAILAND

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ABSTRACT: Geodetic datum defines the size and shape of the earth and the origin and orientation of the coordinate systems used to map the earth. Hundreds of different datum has been used to frame position descriptions. Geodesy and Geophysics Division, The Royal Thai Survey Department (RTSD) is responsible for the establishment of Geodetic Control Network in Thailand using the Global Positioning System, had derived three transformation parameters (ΔX, ΔY, ΔZ) for transforming coordinates between coordinates based on local Indian1975 datum and WGS84 datum for supplying to other authorities of Thailand. In geographic information system, open source and commercial GIS software also provide a tool to transform geographic data to the any local coordinates. That providing tool of those GIS software use different parameters and equations in coordinate transformation. The result of that transformation differs from using our derived parameters. From that inaccurate result, geodetic engineering projects in Thailand were affected. Thus, RTSD has a plan to develop Web-based Coordinate Transformation Service of Thailand (WCTSoT) for providing a suitable and accurate tool for regional use. In this paper, we report the development and discussion of that WCTSoT. The standard specifications such as OGC WPS and WCTS were selected to implement WCTSoT. Finally, the comparison between using our service and commercial software are also reported in this paper.

1. INTRODUCTION

1.1 National Geodetic Control Network with Different Datum

Since 1991, RTSD (Royal Thai Survey Department) have changed surveying method from triangulation and traverse to GPS observation. The reference datum which is a set of constants specifying the coordinate system for a collection of horizontal control points throughout Thailand region was also changed from Indian 1975 to WGS84. Any other set of coordinates which has a different datum requires datum transformation before its comparison. Molodensky transformation equation is selected and used to transform coordinate between Indian 1975 and WGS84. This transformation equation requires three local parameters (ΔX, ΔY, and ΔZ). In this case, Defense Mapping Agency (DMA) from US government and RTSD have jointly co-operation to define that parameters from observation data using Transit system at Doppler stations. The parameters were firstly defined as follows:

$$X_{75} = X_{84} - 206$$
$$Y_{75} = Y_{84} - 837$$
$$Z_{75} = Z_{84} - 295$$

Above parameters were used until RTSD has re-surveyed Zero Order horizontal control network responding to Class AA from FGCC (Federal Geodetic Control Committee) in 2002. That observation data were precise and accurate enough for using to detect Earth's plate tectonics motion. Then, geodetic control network throughout the country was re-adjusted to provide unique and stable network. The result of adjustment showing the coordinates of stations were changed. Transformation parameters were also re-derived for improving accuracy of coordinate transformation. New parameters are defined as follows:

$$X_{75} = X_{84} - 204.5$$
$$Y_{75} = Y_{84} - 837.9$$

$$Z_{75} = Z_{84} - 294.8$$

1.3 Parameters application

In the age of information technology, geographic information system pay an importance role for various geo-sciences due to GI system is designed to use as a tool for integrating and analyzing geographical referenced data. The data which are used in GI system must be referenced to the same coordinate reference frame before analyzing. Most spatial data such vector as road, building, and land parcel which are created from land surveying information before the edge of GPS observation was referenced on Indian 1975. Due to the coordinates at the same point between Indian 1975 and WGS84 are differed in 300-400 meters. Analyzing data between Indian 1975 and WGS84 the coordinate transformation is required.

1.3 Problem and proposed solution

Similar GIS applications provide coordinate and datum transformation function with specific parameters. For example, ArcGIS (version 9.3) provide four set of parameters with two transformation equations (Table 1) for transforming datum between Indian 1975 and WGS84. Not only ArcGIS but other GIS softwares also have its own parameters. Most of that are differences.

Table 1. Transformation parameters in which provided by ArcGIS

Transformation set	Transformation Equation	dx	dy	dz	rx	ry	rz	s
Indian_1975_To_WGS_1984	Geocentric Translation	209	818	290	-	-	-	-
Indian_1975_To_WGS_1984_2	Geocentric Translation	210	814	289	-	-	-	-
Indian_1975_To_WGS_1984_3	Geocentric Translation	204.64	834.74	293.8	-	-	-	-
Indian_1975_To_WGS_1984_4	Position Vector	293	836	318	0.5	1.6	-2.8	2.1

To support Thai's researcher in order to develop geo-science research of Thailand, RTSD proposes Web-based Coordinate Transformation Service of Thailand (WCTSoT) which implements standard OGC WPS for providing datum transformation to public GIS user. This service provides user facility for transforming spatial data with latest parameters.

2. STANDARD

2.1 Standard Geospatial Web Service

Importance key of using standard geospatial web service is interoperability in geographic applications [1]. Especially in WWW environment, interoperability is a capability to communicate, execute programs, or transfer data among various functional units in a manner that requires the user to have little or no knowledge of the unique characteristics of those units [2]. Thus, end-user can analyses complex geospatial data with various resources of data and functions via different providers in the same agreement protocol. In geospatial web services community, these spatial data and functions with different vendors can be integrated and analyzed in order that implementation was following the standards such as OGC web service specifications.

2.2 OGC Web Processing Service

OGC release Web Processing Service (WPS) standard specification for defining a standardized interface facilitating the publishing of geospatial process, and the discovery of and binding to those processes by client [3]. Term of "Processes" can be algorithm, calculation or model that operates on spatial data. Provider can publish their own function with interoperable capability to GIS clients through this standard. User can requests spatial data processing without awareness of a change in algorithm, calculation method in backend which is an improvement of processing capability. Thus, WPS is suitable specification for implementing such processing function as datum transformation which parameters (ΔX, ΔY, and ΔZ) can be changed any time in service backend by developer responding to the reason that described in Section 1.

3. IMPLEMENTATION

WPS provides three operation to client communicate with service; GetCapability, DescribeProcess, and Execute. Through these three operations user can performs data processing with request - response style as following Figure.

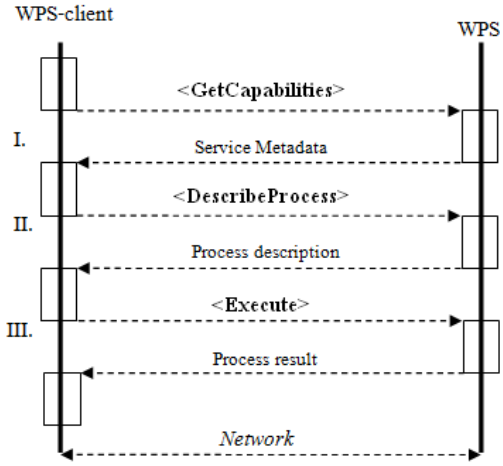

Figure 1. Client-service communication via WPS protocol.

<GetCapability> is used for client request a service capability document. Each processing function can be described by client sends a request message such <DescribeProcess> then the document which is responded will contain the details such as input and output parameters for that processing function. <Execute> is sent to service when client requires processing data. Through these three operations, coordinate transformation service can be developed to provide datum transformation function as following model:

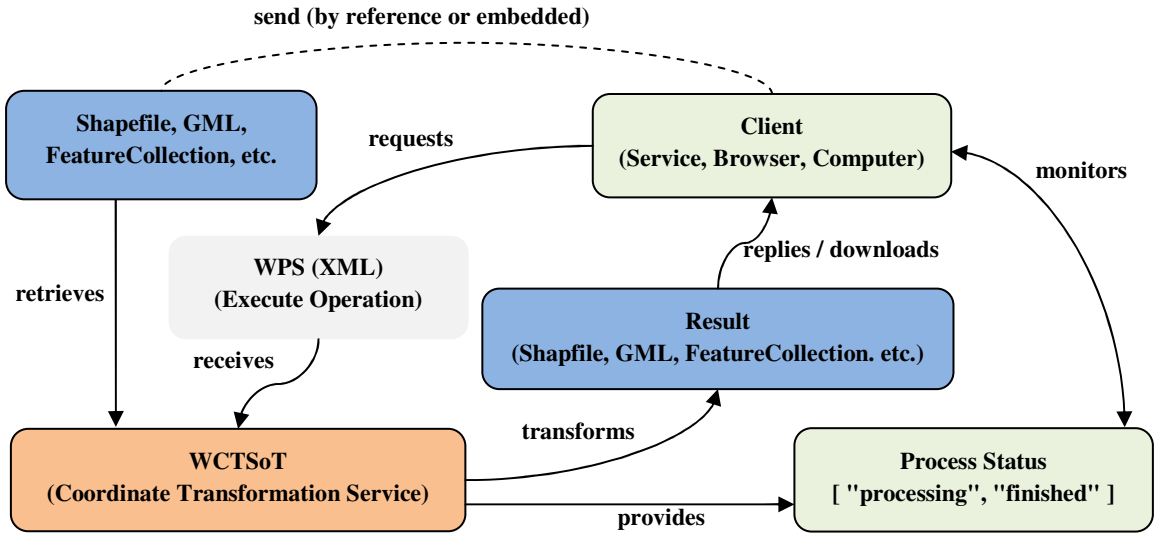

Figure 2. Web-based coordinate transformation service model.

Service is designed to support datum transformation which most popular spatial data such as Shapefile, GML, and wfs:FeatureCollection can be transformed. Client sends request document to WCTSoT which refer to spatial resource as URL. Service will retrieve spatial data by downloading from referenced resource. In case of a large spatial data which requires a time for processing, service provides additional options as "synchronous" and "asynchronous" for client waiting response or checking process status then downloading later. The following XML is an example of request document which requires transforming features (Shapefile format) with a synchronous processing.

```
<wps:Execute ...>
    <wps:Identifier>DatumTransformation</wps:Identifier>
    <wps:DataInputs>
        <wps:Input>
            <wps:Identifier>features</rtsd:Identifier>
            <wps:Data>
                <wps:ComplexData>
                    <wps:Reference xlink:href="http://....">
                    <ows:Format>Shp</ows:Format>
                    </wps:Reference>
                </wps:ComplexData>
            </wps:Data>
        </wps:Input>
        <wps:Input>
            <ows:Identifier>Function</ows:Identifier>
            <wps:Data>
                <wps:LiteralData>Indian1975toWGS84</wps:LiteralData>
            </wps:Data>
        </wps:Input>
        <wps:Input>
            <ows:Identifier>ProcessStyle</ows:Identifier>
            <wps:Data>
                <wps:LiteralData>synchronous</wps:LiteralData>
            </wps:Data>
        </wps:Input>
    </wps:DataInputs>
    <wps:ResponseForm>
        <wps:RawDataOutput mimeType="application/shapefile">
            <ows:Identifier>result</ows:Identifier>
        </wps:RawDataOutput>
    </wps:ResponseForm>
</wps:Execute>
```

4. TESTING

This research focuses on geocentric translation which using Molodensky transformation equation transforms coordinate with three shift parameters in X, Y, and Z axis. Then each parameter set of such GIS software as ArcGIS was tested (Indian_1975_To_WGS_1984, Indian_1975_To_WGS84_2, and Indian_1975_To_WGS84_3). The results produce different solutions as demonstrated in Figure 3. Displacements of the results are ranging from 2 - 3 meters. However, ArcGIS provides special function which allowing user to define custom parameters. But only few persons are aware on using RTSD parameters.

The displacements of the results which are compared between using ArcGIS and WCTSoT are demonstrated in Figure 3. The green line instead of RTSD first parameters and magenta line demonstrates the latest parameters as follows:

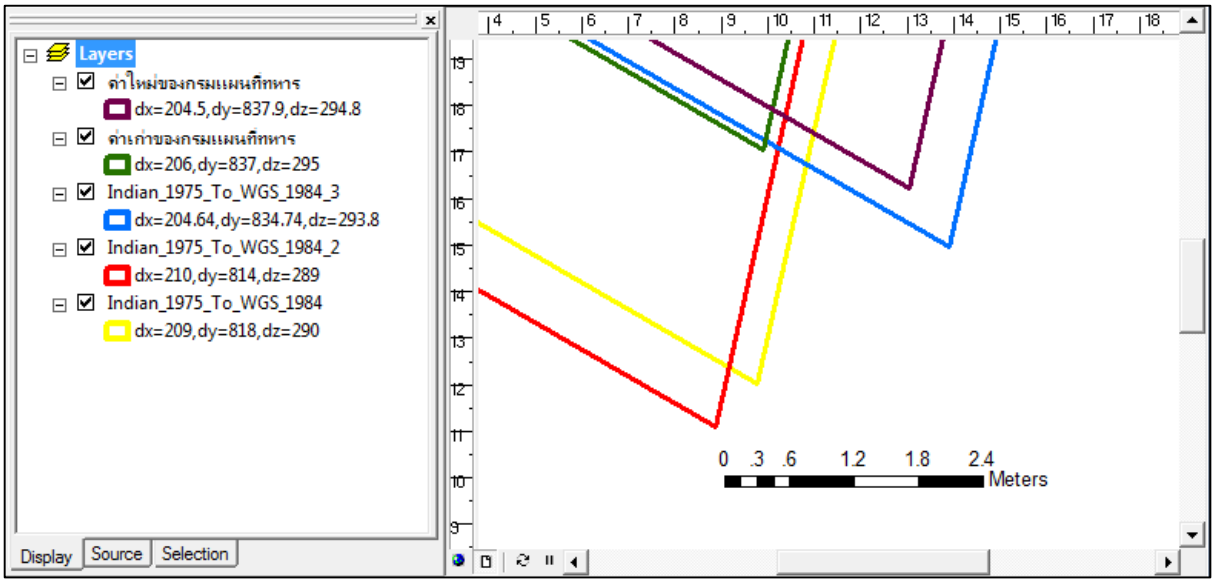

Figure 3. The different vector-layers which each layer is a result of different parameters transformation from the same resource is displayed in ArcGIS.

5. CONCLUSION

In this paper, OGC WPS is implemented for providing coordinate transformation service called Web-based Coordinate Transformation Service of Thailand (WCTSoT). Public clients can use the latest parameters of datum transformation through this service. Thus, when transformation parameters were updated, GIS users can use these values immediately.

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7. REFERENCE

[1] OGC, OGC Reference Model (OGC 08-062r4), 2008.

[2] OGC, *The OpenGIS Abstract Specification Topic 12: OpenGIS Service Architecture Version 4.3*., 2001.

[3] OGC, OpenGIS Web Processing Service version 1.0.0, 2007.