

The Multi-Level Data Exchange with Representational State Transfer on Service-Oriented Architecture

Worrapong Nuam-In, Prachyanun Nilsook, and Panita Wannapiroon

Abstract—In order for government organizations to be geared towards digital government they need to have the basic systems in terms of hardware, software, systems and data in order to support integration. Therefore, the exchange of government data is considered to be the major factor in developing digital government. This article aims to design the service-oriented architecture (SOA) for data exchange within the Ministry of Education in Thailand which has a varied internal structure, by using REST as the “Architectural style” and JSON as the standard for exchanging data according to the information standard that is prescribed by the Ministry of Education.

Index Terms—Data exchange, representational state transfer, REST, service-oriented architecture, SOA.

I. INTRODUCTION

Government agencies need to progress to digital government by ensuring integration between agencies, introducing a smart working system, being people-centered and propelling the entire change based on 4 actions: (1) Government Integration – the introduction of data integration and co-operation between agencies (2) Smart Operations – introducing the appropriate technology and digital gadgets to support the operation (3) Citizen-centric Services - enhancing the government service to serve the population needs (4) Driven Transformation – being a digital government throughout the entire organization in terms of personnel, operations procedure, technology and regulations [1]. The integration of population database and service government reform plan (B.E. 2560-2564) prescribes the procedures for the integration of the population database and government services. This involves the development of the Population Information Linkage Center which links the data system between the Population Information Linkage Center and the Civil Registration Database, and improves the population service system [2] The Ministry of Education is a

complicated and large scale organization which is currently unable to transfer and exchange data [3] completely. Therefore, the use of Information and Communication Technology in the educational context is necessary. Service-oriented Architecture (SOA) is the concept related to the design of an information technology system within government agencies aimed at putting into place a service system which is reusable, and which support the development system with independence and different to integrate between them [4], [5].

II. BACKGROUND

A. Multi-level Data Flow of MOE

Transferring the education data of the Ministry of Education (MOE) begin with the schools in each regional cluster. Individuals schools will collect and transfer data to their regional cluster offices - the Educational Service Area Office. These regional offices will then collect, check and transfer data to the central office. Some schools are currently able to transfer the data directly to the central office. The central office is composed of the Office of the Basic Education Commission, the Office of the Vocational Education Commission, the Office of the Higher Education Commission, the Office of the Private Education Commission, and the Office of Non-Formal and Informal Education [6]. Each central office will collect, check, store and transfer data to the Information and Communication Technology Center of the Ministry of Education. In the event of complicated or error data, the data will be sent back to the data owner which is the central office, the regional office and the school in sequential order. The data owner will update and improve the data then transfer it back again [7]. This is shown in Fig. 1.

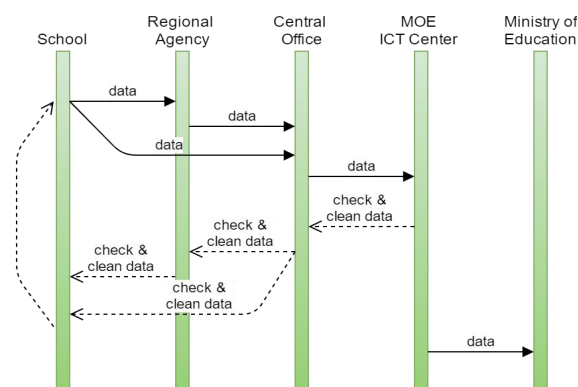


Fig. 1. Multi-level data flow of the MOE.

B. MOE Data Standard

The MOE prescribes and publicizes the standard of

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education data for the internal and external sectors in such a way that they are able to exchange and integrate the data. The data standard in this study consists of 2 components: (1)

Student Data: 46 fields and (2) Graduate Student Data: 23 fields [8] as indicated in Tables I and II.

TABLE I: STUDENT

No	Fieldname	Type	Length	Description
1	AcademicYear	Varchar	4	Academic year of data collection
2	Semester	Varchar	1	Semester of data collection
3	SchoolID	Varchar	10	School code
4	JurisdictionID	Varchar	2	Code of original affiliation
5	JurisdictionPK	Varchar	50	Student Code
6	StudentID	Varchar	15	Student Identification Number
7	PersonID	Varchar	13	Personal Identification Number
8	PassportNumber	Varchar	20	Passport Number (cited authority by Ministry of Foreign Affairs)
9	PrefixCode	Varchar	3	Title (Cited Department of Provincial Administration)
10	FirstName	Varchar	100	Name
11	MiddleName	Varchar	100	Middle name
12	LastName	Varchar	100	Last name
13	GenderCode	Integer	1	Gender code (cited core standard code of the Ministry of Education)
14	Birthdate	Varchar	8	Date of birth (YYYYMMDD)
15	NationalityCode	Varchar	3	Nationality code (cited core standard code of the Ministry of Education)
16	DisabilityCode	Varchar	2	Disability code of physical and mental health (cited 9 types of disabilities of OBEC)
17	Disadvantaged EducationCode	Integer	2	Educational Disadvantaged code (cited 11 typed of Educational Disadvantaged of OBEC)
18	RegisterHouseID	Integer	11	House code number (cited copy of house registration)
19	RegisterHouseNumber	Varchar	100	Address (cited copy of house registration)
20	RegisterVillageNumber	Varchar	100	Number of village (cited copy of house registration)
21	RegisterStreet	Varchar	100	Name of road (cited copy of house registration)
22	RegisterSoi	Varchar	100	Name of lane (cited copy of house registration)
23	RegisterTrok	Varchar	100	Name of alley (cited copy of house registration)
24	RegisterSubDistrictCode	Integer	6	Regional code (province, district, subdistrict)
25	FatherPrefixCode	Varchar	3	Title (Cited Department of Provincial Administration)
26	FatherFirstName	Varchar	100	Father's name
27	FatherMiddleName	Varchar	100	Father's middle name
28	FatherLastName	Varchar	100	Father's last name
29	FatherStatusCode	Integer	1	Code of father's status
30	MotherPrefixCode	Varchar	3	Title (Cited Department of Provincial Administration)
31	MotherFirstName	Varchar	100	Mother's name
32	MotherMiddleName	Varchar	100	Mother's middle name
33	MotherLastName	Varchar	100	Mother's last name
34	MotherStatusCode	Integer	1	Code of mother's status
35	EducationLevel AdmissionYear	Varchar	4	Year of admission/ current education level (B.E.)
36	SchoolAdmissionYear	Varchar	4	Year of school admission
37	EducationLevelCode	Varchar	2	Current code of education level
38	GradeLevelCode	Integer	3	Current grade level
39	CurriculumCode	Integer	2	Curriculum code
40	MajorCode	Integer	2	Major code
41	ProgramCode	Integer	2	Study program code
42	CourseCode	Integer	2	Course code
43	GPA	Decimal	4	GPA scores
44	GPAX	Decimal	4	Grade Point Average
45	LearningCenterProvince	Integer	2	Provincial code
46	PartnerSchoolID	Varchar	10	School code

TABLE II: GRADUATES

No	Fieldname	Type	Length	Description
1	PersonID	Varchar	13	Personal Identification number
2	Prefix	Varchar	40	Title
3	FirstName	Varchar	40	Name
4	LastName	Varchar	50	Last name
5	Birthdate	วคคปป ปป	8	Date of Birth
6	RegisterHouse Number	Varchar	10	Address
7	RegisterVillage Number	Varchar	2	Number of village
8	RegisterStreet	Varchar	80	Name of Road
9	RegisterSoi	Varchar	80	Name of Lane
10	RegisterTrok	Varchar	80	Name of Alley
11	SubDistrict	Varchar	80	Name of subdistrict
12	District	Varchar	80	Name of district
13	Province	Varchar	60	Name of province
14	NationalityName	Varchar	40	Name of nationality
15	SchoolID	Varchar	10	School code

No	Fieldname	Type	Length	Description
16	SchoolName	Varchar	120	Name of school
17	AcademicLevel	Varchar	17	Academic levels
18	CurriculumShort	Varchar	10	Abbreviation for degrees
19	Curriculum	Varchar	100	Degrees
20	Program	Varchar	100	Study program
21	GPA	Decimal	4	GPA scores
22	FinalApproval Date	Varchar	8	Date of import data
23	dateUpdate	Varchar	8	Date of updated data

A. Data Exchange & Communication Protocol

This study uses the Representational State Transfer (REST) style because it is simple and easy to use. It can be used to access the code message while transferring the data of the RESTful web services. JavaScript Object Notation (JSON) can transfer the data in the form of the minimization

data exchange. Therefore, JSON is selected for use in this study [9].

REST is the standard Architecture Style, using JSON to receive and transfer data which is easy to access through URL. The result shows that the data set can process the JSON message code, receive and transfer data specifically through HTTP, and is easy to access using JavaScript. It is more effective than SOAP which use less CPU processor power and a simpler code [10].

Examples of JSON used to transfer Student data and Graduate data:

```
{
  "student": {
    "academicyear": "2538",
    "semester": "1",
    "schoolid": "60101209",
    "jurisdictionid": "01",
    "jurisdictionpk": "1700200370808",
    "studentid": "11451",
    "personid": "4500300280606",
    "passportnumber": "",
    "prefixcode": "01",
    "firstname": "วรพงษ์",
    "middlename": "",
    "lastname": "นามอินทร์",
    "gendercode": "M",
    "birthdate": "25181124",
    "nationalitycode": "001",
    "disabilitycode": "04",
    "disadvantagededucationcode": "21",
    "registerhouseid": "601271",
    "registerhousenumber": "201/3",
    "registervillagenumber": "2",
    "registerstreet": "",
    "registersoi": "6",
    "registertrok": "",
    "registersubdistrictcode": "600108",
    "fatherprefixcode": "01",
    "fatherfirstname": "ทวี",
    "fathermiddlename": "",
    "fatherlastname": "นามอินทร์",
    "fatherstatuscode": "1",
    "motherprefixcode": "02",
    "motherfirstname": "สมนึก",
    "mothermiddlename": "",
    "motherlastname": "นามอินทร์",
    "motherstatuscode": "1",
    "educationleveladmissionyear": "2523",
    "schooladmissionyear": "60101209",
    "educationlevelcode": "M6",
    "gradelevelcode": "12",
    "curriculumcode": "01",
    "majorcode": "01",
    "programcode": "01",
    "coursecode": "",
    "gpa": "3.25",
    "gpax": "3.12",
    "learningcenterprovince": "60",
    "partnerschoolid": "-"
  }
}

{
  "graduate": {
    "personid": "1700200370808",
    "prefix": "นาย",
    "firstname": "วรพงษ์",
    "lastname": "นามอินทร์",
    "birthdate": "12/12/2540",
    "registerhousenumber": "201/3",
    "registervillagenumber": "2",
    "registerstreet": "ไผ่ล้อม",
    "registersoi": "6",
```

```
"registrok": "-",
"subdistrict": "ปากน้ำโพ",
"district": "เมืองนครสวรรค์",
"province": "นครสวรรค์",
"nationalityname": "ไทย",
"schoolid": "6001010140",
"schoolname": "ลาซาลโชติรวินนครสวรรค์",
"academiclevel": "มัธยมศึกษาตอนปลาย",
"curriculumshort": "ม.ปลาย",
"curriculum": "การศึกษาระดับพื้นฐาน",
"program": "-",
"gpa": 3.02,
"finalapprovaldate": "01/03/2561",
"dateupdate": "15/05/2561"
}
}
```

III. SERVICE-ORIENTED ARCHITECTURE: SOA

Service-Oriented Architecture (SOA) is an Architectural Style which is based on a design pattern which is based on the different components of software that have a function for other applied programs through the protocol standard. SOA is a set of services that focus on communication. Communication involves simple data transferring until certain feature the work of two or more services.

SOA for web service has the following:

A standard for communication

The same presentation pattern and data exchange

The details of language which are describable

A registration and searchable pattern on the web service system

Therefore, SOA is an approach that has been used to design the architecture for the service. RESTful is a service which processes small functions such as data setting, data approved from clients, or other basic services [10], [11].

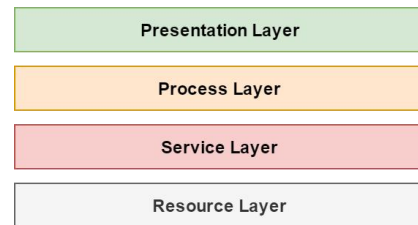


Fig. 2. Conceptual framework of SOA.

IV. MOE DATA EXCHANGE ON REST-SOA

As can be seen in Fig. 3 (left) in terms of the original system of data exchange, the schools transfer data to the central agencies in 2 forms: (1) transfer in the form of Text Files (CSV File or Excel File) by transferring from the File Transfer Protocol (FTP). The Information and Communication Technology Center of the Ministry of Education will examine the files to ensure that they are completely accurate and not over-complicated. Then, it stores the data the database system and (2) transfer in the form of Web Service [12], [13] which uses XML Protocol for transferring and storing data in the database system.

The Service-Oriented Architecture (SOA) for data exchange within the Ministry of Education that has various internal structures is done by using REST as the "Architectural style" and JSON as the standard for exchanging data according to the information standard that has been prescribed by the Ministry of Education. From Fig.

3 (right) it can be seen that the schools can transfer data using the original standard, and it will be changed for access purposes using JSON. The schools and the central agencies can transfer the data directly to the Information and

Communication Technology Center of the Ministry of Education in form of RESTful web services that uses the JSON Protocol through the REST Service Gateway and which then stores the data in the database system [14]-[19].

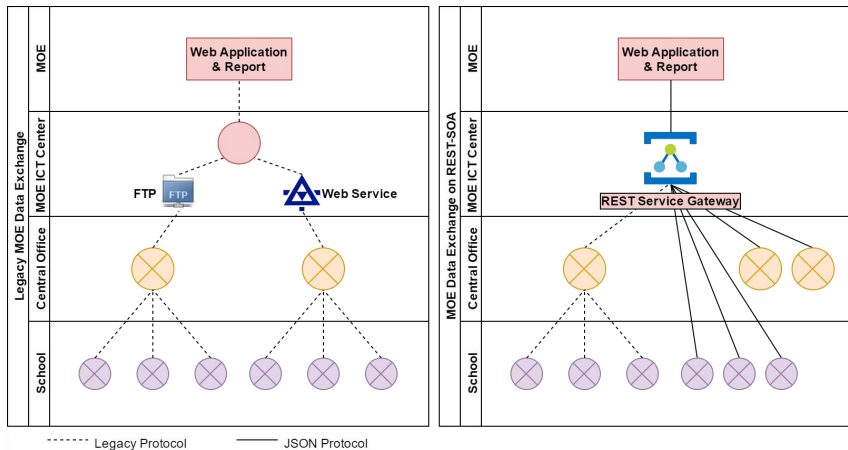


Fig. 3. Legacy MOE data exchange (left) and MOE data exchange on REST-SOA (right).

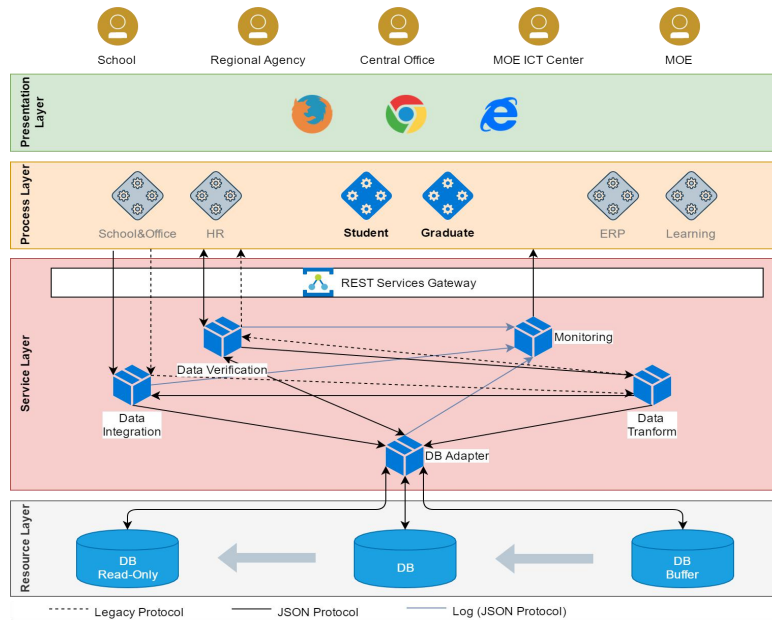


Fig. 4. MOE data exchange on REST-SOA architectural framework.

The design of the MOE Data Exchange on REST-SOA Architectural Framework can be seen in Fig. 4. The architecture is divided into 4 layers, consisting of:

1) Resource Layer. This is the section of resources that is used in storing the data and files. The database can be separated into 3 databases in the form of (1.1) DB Buffer. This is the database used for storing and hanging data to check for accuracy and complications (1.2) DB. This is the main database containing accurate data and (1.3) DB Read-only. This is the main database containing accurate data what is ready for other departments to use.

2) Service Layer is the part that stores all the service. By using the REST Services Gateway is the main service serves as a Service Bus connect Process Layer includes 5 services. As follows:

2.1) DB Adapter Service. This is the center for linkage and converting data for storage in 3 databases.

2.2) Data Integration Service. This is a part for receiving data from schools and central agencies. The data is transferred in 2 types; legacy protocol and JSON protocol. In

the case of the legacy protocol, this will retransfer data to be converted into JSON at the Data Transform Service, and transferred back to the DB Adapter for converting and storing in the database system.

2.3) Data Verification Service. This is a part that examines data for complications and accuracy. If the data lacks accuracy and is complicated, the Data Verification Service will download the data and transfer it back to the owners. They can then improve and return the data. In the event that the data owners use legacy protocol, the system will transfer the data for conversion by the Data Transform Service. After converting, the data is transferred back to the owners.

2.4) Data Transform Service. This is a part that converts data between legacy protocol and JSON protocol.

2.5) Monitoring Service is a part that is used to store the status of operation information include: sending and receiving data, data transformation and commit data into database system.

3) The Process Layer is a part of the business process that

is developed from the service components. Get the value that the user enters into the Service Layer. Special conditions can meet the requirements of the work. It may be the requirement for each task to be done, such as checking the data received from user interface, according to the specified conditions. Record a transaction that must be recorded in a student table and a graduate table.

4) The Presentation Layer is the top part of receiving the presentation or rendered as a contact with the user interface, which is running Business Logic from the developed Process Layer. Users can use the improved program. Therefore, it must be designed for use and user-friendly may be a web application or mobile application.

V. CONCLUSION

The study of the Multi-Level Data Exchange with Representational State Transfer on Service-Oriented Architecture (SOA) uses REST as the Architectural style and JSON as the standard of exchange data. This study uses 2 data standards: student data standard and graduate student data standard. The framework of the architecture which is designed consists of 4 layers; the Resource Layer, the Service Layer, the Process Layer, and the Presentation Layer. The Rest Service Gateway is the center for exchanging data. There are 5 important internal services: the DB Adapter Service, the Data Integration Service, the Data Verification Service, the Data Transform Service, and the Monitoring Service. A further study will deal with the architecture designed to develop and implement the system which is used by schools and departments under the MOE. The MOE will have to transfer the educational data into a unified and standardized form, both in terms of data standards and standard exchange. As a result, the processing of educational information is a convenient and faster to assist decision-making for executives. It can also be integrated with other government agencies. This is the most important basis for the response to (1) The National Education Plan (for B.E. 2560-2579) [20], (2) The Digital Development Plan to Economy and Society [21], and (3) A National Strategy (for B.E. 2561-2580) [22], and will lead to sustainable development with regard to education in Thailand.

CONFLICT OF INTEREST

"The authors declare no conflict of interest".

AUTHOR CONTRIBUTIONS

Worrapong Nuam-In concuted the research, analyzed the data and wrote the paper. All authors had approved the final version.

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