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A Web Service Framework for Effective Transmission of Academic Transcripts across Institutions

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Abstract

An academic transcript is an official document – issued by an educational institution – that contains a detailed record of a student's academic performance throughout the academic period of the student in the institution. By and large, a candidate cannot be admitted into a tertiary institution or offered an employment by a business sector without the use of a transcript to assess the candidate. A lot of bottlenecks are however encountered in sending transcripts across to the institutions that demand them for assessment of candidates. These problems are, (i) administrative delays in processing transcripts, (ii) delays in sending transcripts through courier services, (iii) typo errors in preparing the transcripts manually, (iv) the authenticity of some transcripts can be questionable. All these problems and more hinder the effective use of transcripts in screening candidates for various courses of study in a university or in an employment sector. This work developed a web service framework that can be effectively used for processing and transmitting academic transcripts across various institutions without any hindrance. The architecture of a web service was used by the researchers for developing the web service framework. A web service framework was developed for transmitting academic transcripts as XML documents across various institutions. The XML document – which uses a universally acceptable text-based notation for describing all kinds of data – is the game changer for the effective transmission of academic transcripts across different computer systems and software applications of various institutions. Conclusion: A web service is an application-to-application (A2A) based protocol that enables the server to return XML-based results securely to a client application and not to a web browser that can be prone to hackers. These features facilitate the processing and transmission of academic transcripts across various institutions seamlessly and securely. This work developed a web service framework that can be effectively used by tertiary institutions for processing transcripts and also sending copies of them in real-time to other institutions that demand them for official uses. The developed web service framework would be highly invaluable for tertiary institutions and business sectors for screening candidates effectively for admissions or employment purposes, respectively.

Keywords: Web Service; Academic Transcript; Framework; XML; Institution

INTRODUCTION

The eXtensible Markup Language (XML) is a text-based notation for describing all kinds of data and sharing it between applications over the Internet irrespective of the programming languages and platforms of the systems involved [1]. It was released in February 1998 by the World Wide Web Consortium (W3C), which is the international standards body for the Web. Since then, various kinds of data—including academic transcripts—can be exchanged across computer systems and software applications, such as web services.

A web service is a program module of a web-server application that provides a service to another program module of a client application over the Internet. It is an application-to-application (A2A) protocol because it returns results (such as academic-transcript information) to the requesting client application rather than to a web browser, unlike conventional web-based systems. The client may then store, process, or display the returned data.

Web services communicate using XML and HTTP [2]. XML uses tags to encode information in a textual format readable by both humans and machines. Another advantage of XML is its support for Unicode, enabling virtually any kind of data—including text, mathematical expressions, molecular structures, music, news, or financial reports—to be transmitted across different operating systems and programming environments [2], [3].

Despite these advantages, limited emphasis has been placed on using XML to transport students' academic transcripts electronically through web services. Most institutions still rely on the *e-transcript* system— a digital version of a student's academic record sent electronically for viewing through a web browser. A key advantage of using XML-based web services is that the receiving institution can automatically process the transcript data as needed, whereas further processing of browser-based e-transcripts must be done manually.

This paper demonstrates how an academic transcript can be represented in XML format and transmitted through a web service for automated use by receiving institutions. The implementation follows the architectural model provided by IBM documentation [4].

LITERATURE REVIEW

A transcript is an academic record that details all the academic performance of a student throughout the years spent in a higher institution of learning [5]. According to BorderPass [6] and World Document Services [7], a transcript typically contains: (i) institution details (name, address, phone number, etc.), (ii) student information (name, ID number, date of birth, etc.), (iii) academic record (completed courses, credit hours, grades, etc.), (iv) grading system and explanations, (v) cumulative academic performance such as CGPA, (vi) degree information (degree conferred, graduation date, field of study), and (vii) certification details (issue date, registrar's signature, institutional seal).

A transcript is usually required when a student transfers to another institution, applies for a graduate program, or seeks employment or scholarship [6], [8]. According to BorderPass [6], institutions or employers request transcripts to: (i) verify the authenticity of claimed degrees, (ii) ensure the candidate completed required prerequisite courses, (iii) compare grades across differing grading systems, and (iv) evaluate academic records for scholarship consideration.

Transcripts exist in two main types: official and unofficial transcripts [8]. An official transcript is a certified document issued directly by an institution's registrar, typically printed on secured paper or as a certified PDF containing the school seal and registrar's signature. It requires a formal request and payment, and is used for admissions, employment, or scholarship applications. An unofficial transcript is an uncertified copy accessible through a student portal, printed on plain paper without official signatures. It is used for academic advising and for students to monitor their academic standing.

To request a transcript, a candidate typically checks institutional requirements, fills out a request form, provides identity documents, pays processing fees, and selects a delivery method [8]. However, requesting a physical (paper-based) transcript can cause issues such as administrative delays, courier delays, typographical errors, and concerns over authenticity. Oluwaseyitanfunmi *et al.* [9] identified these problems as "transcript delays," which have caused many students to lose opportunities for admission or employment.

Electronic transcript delivery has proven safer and faster than manual methods. As noted by Rattagool *et al.* [10], the shift from paper-based academic record

management to digital technologies marks a major advancement in the issuance, storage, and verification of educational credentials. Similarly, Abdulkareem and Hatif [11] developed an e-transcript system that addresses common manual-system issues such as delivery delays and human errors. Other improved e-transcript systems include those developed by Harris *et al.* [12], Mosinmiloluwa *et al.* [13], Adekigbe and Amosa [14], and Ajayi *et al.* [15].

One of the state-of-the-art approaches in digital transcript systems is the use of XML-based web services. Because web services use XML, they support seamless collaboration between heterogeneous systems. Companies such as Amazon, Google, eBay, and PayPal employ web services for interoperability [2]. Only a few XML-based web service e-transcript systems exist, including those by Garikipati and Lim [16] and Kwak *et al.* [17]. Garikipati and Lim demonstrated various web-service technologies such as SOAP, HTTP, REST, UDDI, and XML, all of which work together to enable efficient exchange of transcripts and other data across global heterogeneous systems. Kwak *et al.* developed a framework for e-transcript systems that supports dynamic conversion between XML and EDI.

In this work, the authors demonstrate clearly how student transcript data can be encoded in XML and transmitted through web services for interoperability across heterogeneous systems, enabling unlimited use by institutions or businesses for admissions, employment, or other purposes.

RESEARCH METHODS

The architecture of a SOAP web service, shown in Fig. 1, was used in this work as a roadmap for developing the proposed system, "a web service framework for effective transmission of academic transcripts across institutions," following the IBM SOAP Web Services architectural model **[18]**.

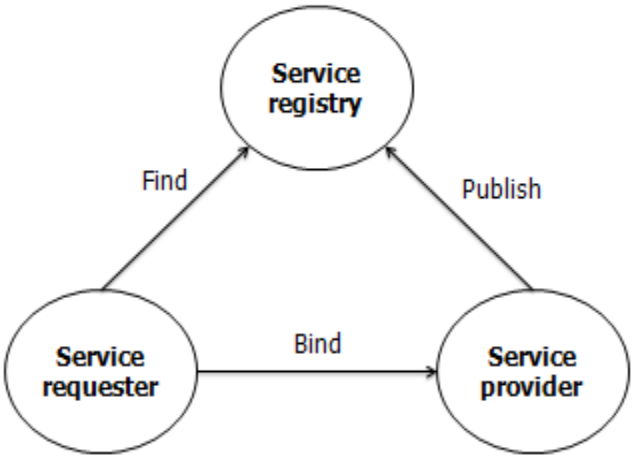

Figure 1. SOAP web services architecture

Source: https://www.ibm.com/docs/en/cics-ts/6.x?topic=format-soap-web-services-architecture

Figure 1 shows the three main components of a SOAP web service: (i) Service Provider, (ii) Service Registry, and (iii) Service Requester **[19]**.

- **Service Provider:** This is the web server that hosts the actual web service application that provides services to the users (service requesters). The application may be implemented using Java, Python, or .NET technologies **[20]**. An academic institution implements a web service that stores students' academic records and deploys it on a web server to provide transcript services to other institutions **[19]**.
- **Service Registry:** Also known as UDDI (Universal Description, Discovery, and Integration), it serves as a repository containing descriptions of available services, including URL endpoints and method definitions **[23]**. All registry data is written in XML and stored as a Web Services Description Language (WSDL) file **[22]**. After the web service is deployed, its usage information is published to the registry through WSDL **[22], [23]**.
- **Service Requester:** The client application that consumes the service. The requester queries the service registry to locate the service and obtain communication guidelines **[19]**. The requester then develops a client program using any programming language capable of making Remote Procedure Calls (RPC), embedding student information such as matriculation number, department, and course of study **[19], [21]**.

SOAP–Based Data Exchange Sequence

i) The client's RPC binds or connects to the service provider via SOAP **[20]**.

ii) SOAP converts the client message into XML and encapsulates it into a SOAP message, transmitted via HTTP **[20], [24], [26]**.

iii) The service provider unwraps the SOAP message and identifies the requested operation, such as transcript retrieval **[20]**.

iv) The provider packages the result into a new XML-based SOAP message and sends it back through HTTP **[20], [24]**.

v) The client unwraps the message and obtains the student's transcript, which may then be processed, stored, or displayed **[19], [25]**.

DATA ANALYSIS

The SOAP web service architecture earlier shown in Fig. 1 can be extended into the operational framework illustrated in Fig. 2 for effective transmission of academic transcripts across institutions **[19], [28]**.

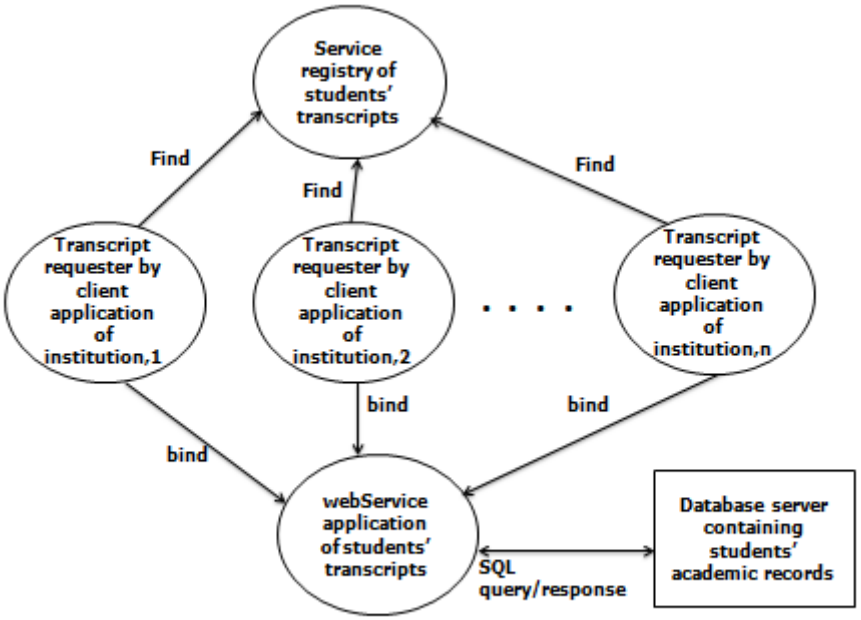

Figure 2. a web service framework for transmitting academic transcripts

The database server contains tables of students' academic records—such as *STUDENT* and *RESULT*—managed by the service provider application **[27]**.

The service provider hosts the application program implemented in Java, Python, or .NET to interface with the database server and process transcript data **[27], [29]**. The core function of the service provider, such as: getTranscript (studRegno, dept,

courseofstudy) is responsible for generating a transcript based on input student data received from the service requester **[19], [30]**.

Any of the requesting institutions (1 to n) discovers the method *getTranscript(...)* from the service registry and implements a suitable RPC-based client program to retrieve transcripts from the service provider **[22], [23]**.

RESULT AND DISCUSSION

When the client application submits student data to the web service application through RPC for transcript retrieval, the student data is automatically converted into XML and transported to the server as a SOAP message **[31], [32]**. Figure 3 shows a sample of such XML-based SOAP message when the following student data are submitted:

- Student matriculation number: '2024/286157'
- Department: 'Computer Science'
- Course of study: 'Software Engineering'

SOAP Request

```
<?xml version = "1.0" encoding = "UTF-8">
<S:Envelope xmlns:S=http://schemas.xmlsoap.org/soap/envelope/>
        <S:Header/>
        <S:Body>
                <ns1:getTranscript xmlns:ns1=http://unn.greg.com/>
                        <Regno>2024/286157</Regno>
                        <dept>Computer Science</dept>
                        <course>Software Engineering</course>
                </ns1:getTranscript>
        </S:Body>
</S:Envelope>
```

Figure 3. an example of xml-based SOAP message Request from the client to the server

When the web service application receives the SOAP message request from the client, it extracts the actual XML message and interacts with the database server to retrieve the transcript and prepare a valid SOAP response **[33], [34]**. The result is then converted back into XML as a SOAP message response and transported to the client through HTTP protocol **[35]**. Figure 4 shows a sample of such SOAP message response.

SOAP Response

```
<?xml version = "1.0" encoding = "UTF-8">
<S:Envelope xmlns:S=http://schemas.xmlsoap.org/soap/envelope/>
        <S:Body>
            <ns1:getTranscriptResponse xmlns:ns1=http://unn.greg.com/>
                <return>UNIVERSITY OF NIGERIA, NSUKKA
                FACULTY OF PHYSICAL SCIENCES
                DEPARTMENT OF COMPUTER SCIENCE

                STUDENT TRANSCRIPT

                student name:  Alumonah Christabel Charity
                gender: F
                matriculation number:  2024/286157
                course of study:  Software Engineering
                level of study:  100

                course code   course title          unit load  score  grade  point
                cos103        computer hardware     3          68     B      4
                cos105        intro. to computer sc. 2         52     C      3
                GSP101        use of English        2          65     B      4
                GSP111        use of Library        2          36     F      0
                MTH111        Elementary Maths I    3          57     C      3
                MTH121        Elementary Maths II   3          66     B      4
                PHY115        General Physics I     2          60     B      4
                STA131        Inference             2          42     E      1

                Semester GPA = total cumulative / total unit load  =  57/19  = 3.0
                </return
            </ns1:getTranscript>Rirsponse
        </S:Body>
</S:Envelope>
```

Figure 4. an example of a xml-based SOAP message Response from the server back to the client

The client application, upon receiving the SOAP message response, extracts the XML data and may store it in a database, display the transcript in a web browser, or further process the data for institutional screening or verification **[36]**.

Limitations of the Study

The methodology employed in this work applies only to SOAP-based web service architecture. Another common web service paradigm used for cross-platform data communication is Representational State Transfer (REST), which uses Uniform Resource Locators (URLs) for exchanging data **[37]**.

CONCLUSION

The use of XML-based web services puts to rest all manner of compatibility issues when heterogeneous systems are exchanging data over the Internet. It is very secure because it is an application-to-application based protocol that delivers results directly to a client application, and not to a web browser that is prone to attack by hackers. Although the e-transcript system can be effectively used for transmitting academic transcripts from one institution to another, its major limitation lies on the fact that no further processing can be performed on the transcript digitally in screening candidates

for admission or employment; any such processing can only be done manually – which is inefficient. This is where the use of XML-based web services becomes very important because it not only possesses interoperability and security capabilities but also enables the client application to do further processing on the data as desired for screening candidates.

Utilizing web services for academic transcript transmission across various institutions is the state-of-the-art technology that should be adopted by all academic institutions and businesses for effective screening of candidates for admissions, employments, scholarships, etc.

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