DESIGN AND IMPLEMENTATION OF AN ELECTRONIC VOTING SYSTEM: A CASE STUDY OF LAGOS STATE UNIVERSITY STUDENTS' UNION

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ABSTRACT

This paper detailed the design and deployment of an electronic voting system for Lagos State University (LASU) Students Union Elections. The electronic voting system was developed in order to allow students to cast their votes in a more convenient manner while also ensuring improved efficiency of the voting process; this is expected to significantly reduce the defects associated with traditional voting processes such as mistakes and electoral malpractices. The electronic voting system deployed helped to solve the various problems associated with a conventional voting system that depends on physical ballot papers and boxes. The implementation is based on a combination of hardware such as fingerprint scanners, internet modems, and switches as well as software applications used in configuring the electronic voting platform which includes PHP (used for server-wide interactions), MySQL (for database management), HTTPS (for provision of additional security to eliminate external interference with the system, and web browser (to access the voting platform).

Having tested the electronic voting system during the LASU Students Union elections under the supervision of the Vice-chancellor and other management members of the institution, the system was adjudged to have made possible, free, and fair elections, with election results released immediately without any form of delay. The implementation of an electronic voting system for the electoral process in LASU ended as a success. Everybody who participated in the process applauded the system and even encouraged it to be taken to the next level. Hence, it is thus recommended.

INTRODUCTION

Voting is an essential part of any government. Voting in a general election is the way citizens of a nation express their opinion in selecting the best candidate to lead them. Voting is the way citizens of a country express their opinion in a bid to elect the best candidate to lead the people. Subject to the 1948 Universal Declaration of Human Rights, several nations have continued to seek means to improve voting procedures (Salomonsen, 2005). While voting has remained manual for a very long time, the influence of Information Technology has led to the emergence of computerized and online voting systems aimed at improving the efficiency of the voting system (Cranor, 2011). The accuracy of election processes is fundamental to the integrity of democracy; hence, the need for the adoption of more effective means of undertaking the voting process.

Over the years at the Lagos State University (LASU), elections have been held by adopting the open and/or secret ballot system. However, these systems have been observed to provide avenues for all sorts of electoral malpractices aimed at rigging the elections to favor a particular candidate. All attempts to curtail the occurrences have yielded very few results. In other words, the prevailing voting systems adopted by LASU Student Union for its elections have proved grossly inefficient, leading to low voter turnout, inaccessibility of election venues due to distances to be covered, and voters' apathy towards the electoral process. Also, the manual collation of results

provides room for the manipulation of electoral figures. Technological advancements have led to the emergence of an electronic voting system. And this has availed LASU to keep abreast of the emerging technological innovations to develop a computerized voting system as a permanent alternative to the traditional paper voting system. It is believed that the electronic voting system will curb, and possibly eradicate the several forms of electoral malpractices that have become commonplace in LASU's Student Union elections.

Considering the above, the objective of this paper is to design and implement a computerized and automated real-time system of voting that will be capable of tackling the issues of the insecure and ineffective voting process in LASU Students Union elections. The developed system will have specialized features that will enhance the security of the system to eliminate multiple voting, and capture biometric data, while also reducing the time involved in the whole electoral process. by so doing, LASU Student Union will have an accurate database of the students. Although the system to be developed in this paper can be applied to areas where a multitude of persons are required to make choices in divergent locations, the scope of the design is focused on the implementation of a seamless voting system for LASU Student Union elections. This required the design of software for voting which can establish a connection between remote systems on a central server hosted on the internet. The software is designed using PHP MySQL. A web server was hosted on the internet to enable the connection between the remote system

LITERATURE REVIEW

The effectiveness of voting processes has become more important owing to the improved democratization of countries across the globe. With the emergence of computers, virtually all areas of human engagement have been positively impacted. The use of computers for voting processes such as voter registration, vote recording, and vote counting has led to improvement in the voting process as a whole. While it may be argued that the initial cost of designing and developing a computerized voting process could be high, it has been noted that such a process results in a drastic reduction of the overall costs expended on the voting process. Computerized voting processes make obsolete, the use of ballot boxes and papers; by implication, printing costs are greatly reduced.

Electronic Voting

Electronic voting is the means of voting using electronic devices. It is comprised of the adoption of a computerized system, rather than the traditional use of ballot boxes, situated at polling centers (Anderson, 2006). Electronic voting (also known as E-voting) is a term encompassing several different types of voting, embracing both electronic means of casting and counting votes. According to Smith and Clark (2005), electronic voting is the next logical step toward the application of online information gathering and data retrieval technologies for e-government. The process of electronic voting results in reduced cumulative costs of running elections while also increasing voters' participation due to the ease and convenience of the system. A great number of countries around the world are embracing the electronic voting system due to the convenience and ease the system offers (Awad and Ernst, 2011). According to Sergei et al (2011), quite a number of electronic voting systems have been developed. Electronic voting in Estonia began in October 2005 local elections when Estonia became the first country to have legally binding general elections using 11 the Internet as a means of casting the vote and was declared a success by the Estonian election officials. The Estonian experience of deployment of e-voting enabled by the internet in the USA proved secure despite worries relating to hacking and vote count manipulations (Heiberg et al, 2011).

During elections of the Faculty of Engineering, Lagos State University (LASU) Epe in 2012, an electronic voting system, designed and implemented by our team was adopted. The system allows students to cast their votes using a computer (laptop). The computers were connected using a Dlink switch. The voting software was installed on a local server and every other computer on the network connected to the server. Students were checked in manually by an electoral officer and each student was asked to fill out a register. Everybody who participated in the process applauded it and commended the software developer. As much accolades as the developed software got, it had its own lapses which are;

(a) The Electoral Officer in charge of checking students in could allow a student that has already voted in again but using a different matriculation number, as students were asked to submit their matriculation numbers before voting.

(b) Students might beat the system using a non-valid matriculation number since there is nothing to check the validity of the matriculation number.

(c) Whoever is asked to manage the local server could access the backend to manipulate 12 election results.

To eradicate this defect, there is a need to design and develop an e-voting system that would make use of multiple factors for authenticating voters' identities and ensure that the lapses of the aforementioned e-voting process are eradicated. Invariably, the design and implementation of a two-factor authentication electronic voting system are expedient.

Two-Factor Authentication of Electronic Voting

Two-factor authentication is a method used by a computer to grant access to a user, subject to the presentation of two or more pieces of evidence, known as factors (Rosenblatt and Cipriani, 2019). In other words, access to the voting portal is granted to the user upon presentation of two or more pieces of information that are unique and specific to that particular user. The essence of this is to confirm the user's identity through a combination of something they possess or something they have been given. The use of Two-factor authentication is premised on proving the identity of the user prior to granting access. In the process of authentication, if at least one of the factors presented is not correct, missing, or not completed, the user is deemed to have supplied insufficient information to be granted access. The factors to be presented can be a personal identification number (PIN), password, generated token, or passphrase (Adeoye, 2012).

In the case of the LASU Students Union election, two-factor authentication would be the presentation of the student's matriculation number and a token generated. It should be noted that the token generated for a particular student can only be used by the such student because it has been linked to the student's matriculation number. In other words, any mismatch of token and matriculation number results in the student not being granted access to the voting portal.

MATERIALS AND METHODS

The development of the electronic voting system is predicated upon the software development lifecycle stages which include conception, requirement modelling, design, coding and debugging, testing, and release. At the various stages of the software development life cycle, the best tools and methods were adopted in order to achieve the best results. The E-voting portal would allow voters (i.e., students) to vote from a particular VC (Voting Centre) and the result displayed immediately after the election process is complete.

The implementation of the project occurred on the day of the Lagos State University Students'

Union's Elections (LASUSU Elections) which was conducted and overseen by its Independent Electoral Committee (LASUSU-IEC). The Elections took place at ten (10) different polling units (Faculties) namely;

1. Faculty of Engineering, Epe

2. Faculty of Sciences

3. Faculty of Social Sciences

4. Faculty of Law

5. Faculty of Arts

6. Faculty of Management Sciences

7. School of Communication, Surulere

8. School of Transport

9. School of Medicine, Ikeja

10. Faculty of Education

The connection within each faculty can be regarded as an 'Intra-Faculty Connection' and that that connects the ten faculties together can be regarded as an 'Inter-Faculty Connection'. Inter-Faculty Connection:- The connection within each faculty was done using a 24-port Dlink switch, which is used to connect the systems available within the faculty inclusive of the internet modem. This connection enables the computer systems to share an internet connection as provided on the internet modem.

The materials used for the electronic voting process include computers, fingerprint scanners, internet modems, switches, and RJ45 cables. These were complemented with software applications comprising voting software, database schema, web server, and server security (HTTPS).

Database and System Specifications

MySQL serve was adopted for the implementation of the back-end of the electronic voting system that was designed,

with access to the database serve only possible through the admin interface. The database contained information relating to the candidates, voters, and the election results obtained. This is provided in the table below:

Table 1: Voter Attributes

Field	Type	Null	Key	Default	Length
Voter_id	Numeric	No	Primary	None	12
Image	Varchar	No	-	None	40
First name	Varchar	No	-	None	20
Last name	Varchar	No	-	None	20
Sex	Varchar	No	-	None	7
Course	Varchar	No	-	None	30
Cat_id	Int	No	Foreign	None	15

Table 2: Candidate Attributes

Field	Type	Null	Key	Default	Length
Cand_id	Int	No	Primary	None	20
First name	Varchar	No	-	None	20
Last name	Varchar	No	-	None	20
Image	Varchar	No	-	None	40
Username	Varchar	No	-	None	25
Position	Varchar	No	-	None	20
About	Varchar	No	-	None	60
Voter_id	Numeric	No	Foreign	None	12
Cat_id	Int	No	Foreign	None	15

Table 3: Election Results attributes

Field	Type	Null	Key	Default	Length
Result_id	Int	No	Primary	None	15
Cat_id	Int	No	Foreign key	None	15
Vote count	Int	No	-	None	20
Cand_id	Int	No	Foreign	None	20

Interaction with the System

The electronic voting system is designed to ensure an efficient and easy-to-use graphical interface; it is expected to be managed by the LASU Students Union electoral body for the observance and administration of the election process. the electoral body is also responsible for the declaration of the final results as provided by the electronic voting portal. Every polling unit was equipped with the requisite electronic devices (laptops, finger scanners, printers, etc) that will ensure the smoothness of the whole election exercise. All polling unit computers are linked to the main system server, and anybody who wants to vote is expected to have his or her information on the

database of the main server. In other words, the system architecture is provided below:
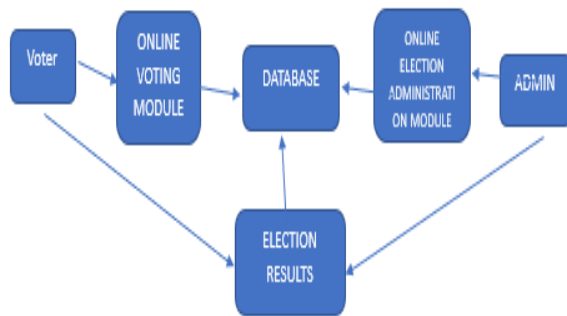
LASU Student Union Electronic Voting system architecture

ONLINE VOTING MODULE

The online voting module presents a pathway for students to access the voting portal. This module can only be accssed in designed points referred to as polling units. These units are equipped with the requisite devices needed to ensure the success of the electronic voting system. The computers to be used for the voting process are first accessed by the election officer whose responsibility is to confirm the validity of the voter coming to exercise their constitutional duties. The electoral officer is a provider with a login that enables the computer to provide access for subsequent use by a student that intends to vote. The algorithm of the voting process is provided below:

Step 1: The voter walks into the voting center and presents his/her matriculation number.

Step 2: Electoral officer (EO) checks for the voter's details through his/her matric number. He also checks if the voter has voted before or not.

Step 3: If a voter has voted before, the EO sends him/her away but proceeds to take the voter's fingerprint if he/she hasn't voted before. The fingerprint does two things i.e. checks if the

voter has voted before or not and also enrolls the voter.

Step 4: The EO generates a unique token for the voter which can only be used against the matric number the voter submits. Step

5: The voter proceeds to the available system to cast his/her votes.

Step 6: The voter logs in to the voting portal with his/her matric number and the token is given to him/her.

Step 7: The voter casts his/her votes after gaining access to the voting portal but will be denied access to the voting page if he/she has cast his/her vote before with either the matric number or the token or both.

Step 8: A preview page is shown to the voter after he/she is through with his/her votes, to enable him/her to make changes to his/her choices of candidates.

Step 9: The voter enters his/her phone number and e-mail address and also clicks the submit button to end the vote and also render his/her matric number invalid to vote again. The voter receives an SMS and an e-mail message immediately, showing his/her votes.

Step 10: The system returns to the initial page i.e. the 'I want to vote' page, to allow the next voter to register his/her vote.

Upon signing in, the details of the student are provided as it is on the database. This avails the student to register for the voting exercise.
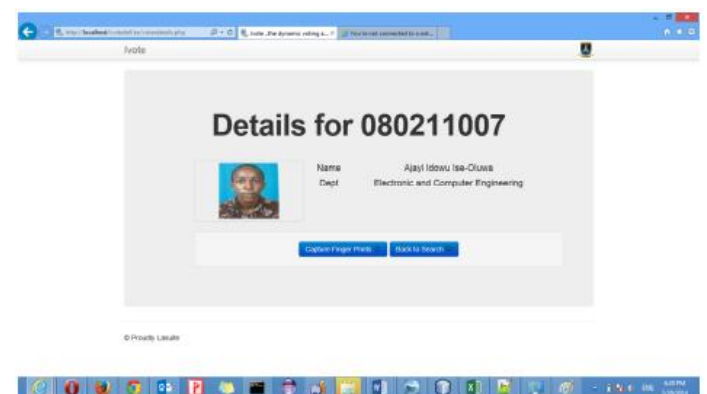
Upon successful registration to vote, a token is generated for the student to access the main voters' page. At this point, the token is attached to the student's matriculation number; the two represent the two factors to be authenticated for access granted to the voting page.
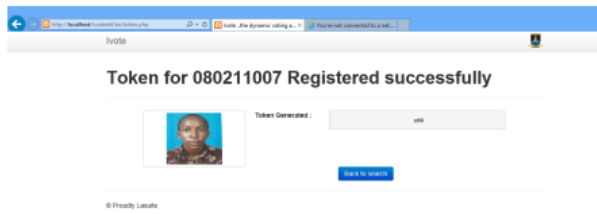

The token and the matriculation number are entered into the voting portal in order to be granted access to the voting platform.
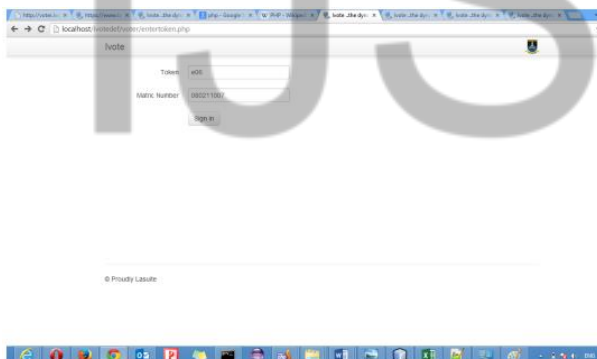

After the generation of tokens, the voter proceeds to the voters' page to register his/her votes as he/she deems fit. The combination of the matriculation number and token generated for the person can't be used again to register any vote once the voter clicks the 'submit' button at the end of the vote. If a such person should come forward again to use the combination of matriculation number and token generated, such person will be denied access to voting again. The picture below shows the welcome page and the voter can

cast his/her vote by clicking the 'continue' button.
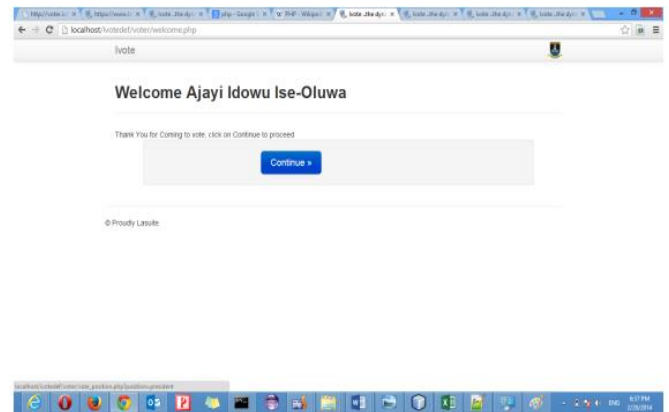
Upon clicking the 'continue' button, the student is taken to the page showing the first set of candidates for a particular elective position. In case the student does not want to vote for any of the candidates for such a position, he/she only needs to press the 'skip' button to move to the list of candidates for the next elective position available on the voting portal.
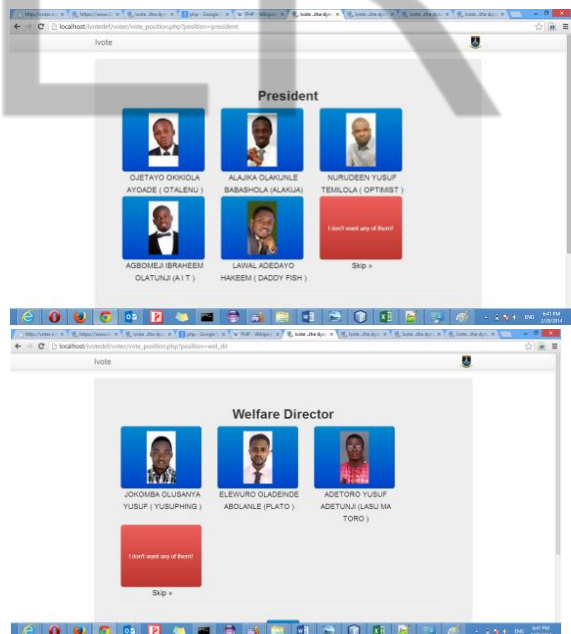

This process goes on for all the elective positions that are available for students to vote for. Upon successful completion of the candidate voting steps, the student is moved to the confirmation page. This page shows a summary of all the candidates chosen by the

student for their respective elective positions. This is a preview of the candidates picked by the student, just in case there is a need for changes in the choice of candidates. In the case of no changes, the student clicks the 'submit' button to bring the voting process to an end.
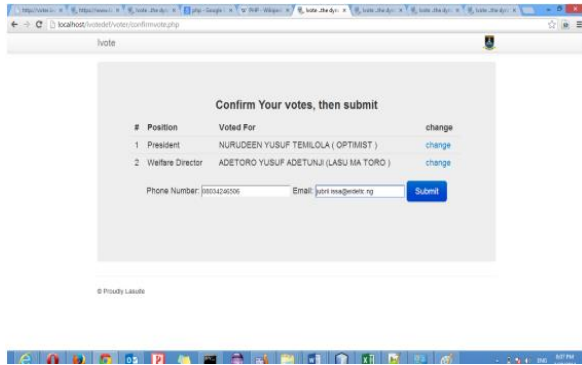
Successful completion of the voting process takes the computer back to the login page. If the student proceeds to log in again after completing the voting process, access is denied. This is shown below
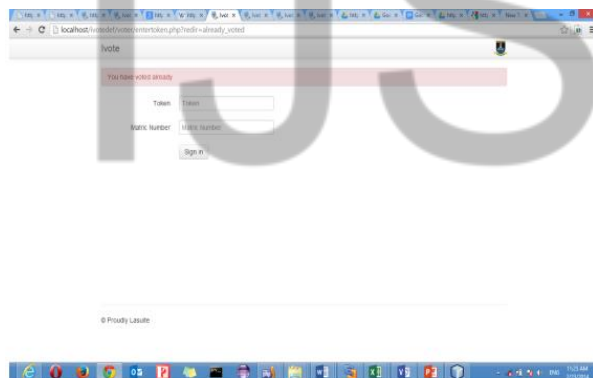
The following action should take place if the normal flow doesn't go as planned:

Case 1: Once the voter tries to re-enter the token after completion of the vote, it should be disallowed

Case 2: The session of a voter expires once the submit button is clicked, so the back button won't work once the submit button has been hit for a particular voter.

Case 3: If a wrong token is entered by the voter, it should alert the voter that the wrong token has been entered and that the token should be checked and re-entered.

Case 4: If a voter mistakenly closes the window of the voting page and has not yet submitted, The token still remains valid and should only become invalid once submit button is clicked. N.B: Voter pc should not be able to search and acknowledge voters.

The Results Module

This module provides information regarding the total votes cast during the election as well as the winner of every elective position that was voted for. The results are made accessible on completion of the voting exercise at a stipulated time which has been inputted into the system. the candidate with the highest votes in each elective category is declared the winner of such category. The module also provides information on the number of people that did not vote for any candidate in specific elective positions. The pictures below show the result page of the LASU Students Union elections, revealing the total votes for two elective positions: SUG president and SUG welfare director.

Presidential

Welfare Director
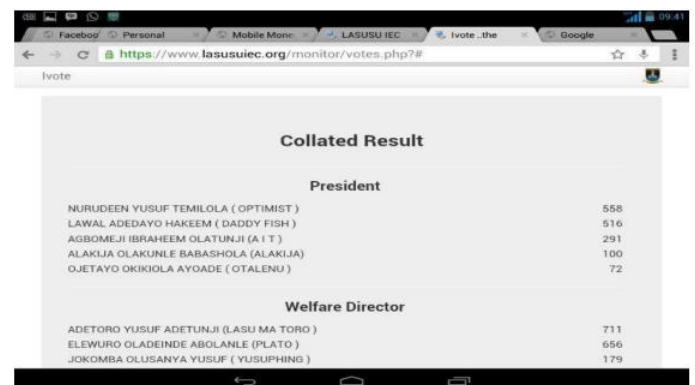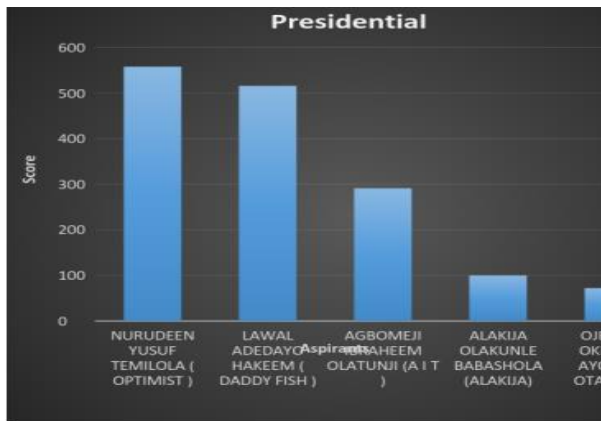
CONCLUSIONS AND RECOMMENDATIONS

The paper provided a detailed analysis of the essential properties needed to design and implement a secured and effective electronic voting system. The objective is to design and implement a real-time application for electronic voting in Lagos State University (LASU) Students Union elections. The electronic voting system is designed to satisfy several essential components of cost-beneficial and fair elections which include integrity of the process, the efficiency of the electronic voting system, ease of use, verifiability, and authentication. The electronic voting system designed would ensure that students cast their votes without the need to move far distances or converge in public places to vote.

The adoption of the electronic voting system was observed to result in an increment in the participation of students in the election. Also, the system was able to eliminate several electoral malpractices and fraud that has become commonplace prior to the adoption of the electronic voting system in the institution. The electronic voting system designed helped to curb the defects of conventional electoral processes. Issues such as time wastage, mobility and convenience of voters, efficiency and timely accessibility to election results, zero-tolerance electoral malpractices, and overall improvement in the electoral process of LASU Students Unions elections.

The first recommendation is that the management of LASU should adopt the electronic c voting system as an alternative to the traditional voting system being used by other associations within the institution. Also, the electronic voting system should be adopted by other electoral bodies in the country such as the Independent National Electoral Commission (INEC) as well as other state electoral bodies. However, there is a need for improvement if the designed voting system will be adopted on a larger scale. Firstly, there is still room for improvement, and it is basically in the area of configuration, integration, and logistics.

- Configuration: - This simply explains the fact that we had to configure the Internet Explorer (IE) at every remote location i.e. Faculties, which proves to be tasking. To curb this, special machines that enable ActiveX at default enable certain and all features within the application.
- Integration: - This deals with integrating certain features used during the Implementation of this project into the program coding. Some of those features used are Short Message Service (SMS), Hypertext Transfer Protocol Secure, Fingerprint SDK, and Database on the server, etc.
- Logistics: - This is one of the concerns of the LASUSU-IEC on the day of the elections. Because the configuration wasn't done appropriately before moving the systems to their locations, we had to go to so many faculties to do some things we could have done earlier.

The challenges will be essential for the wider adoption of the electronic voting system designed in this paper as this will further result in the conducting of peaceful, free, and fair elections in the future.

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