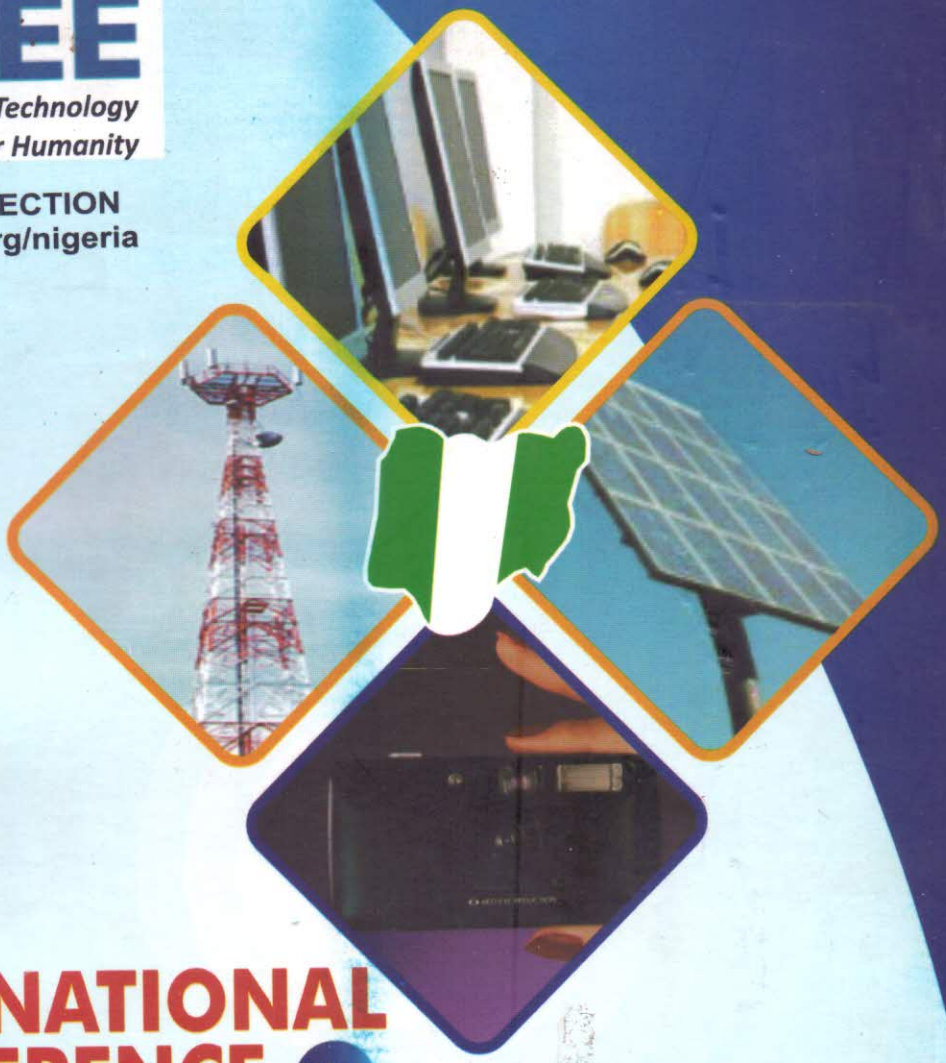
IEEE
Advancing Technology for Humanity

NIGERIA SECTION
www.ieee.org/nigeria



2ND INTERNATIONAL CONFERENCE ON

EMERGING AND SUSTAINABLE TECHNOLOGIES FOR POWER AND ICT IN A DEVELOPING SOCIETY

IEEE NIGERCON 2013

PROCEEDINGS

NOVEMBER 14 -16, 2013

LINKS HOTELS,
NEW OWERRI COMMERCIAL AREA, IMO STATE, NIGERIA.

EDITED BY
IFEYINWA E. ACHUMBA, Ph.D. MIEEE
UCHENNA H. DIALA, MIEEE
EHINOMEN E. ATIMATI, MIEEE

www.nigercon.info

TABLE OF CONTENT

PREFACE:

LIST OF PAPERS:

Towards an Iterative Maintainability Web Service Model for Effective Mobile Healthcare Delivery

Adeoye Olamide Olayinka, Misra Sanjay, Olaniyi O. Mikail, Ahmed Aliyu
Department of Computer Engineering
Federal University of Technology
Minna, Niger State, Nigeria
olaexcel@gmail.com, smisra@futminna.edu.ng, mikail.olaniyi@futminna.edu.ng, aliyu.ahmed@futminna.edu.ng

***Abstract*—Web services are key component of software engineering design due to its inherent merits such as portability, testability and maintainability. It serves as a means of exchanging information over the Internet across several platforms, programs and protocols. However, Web services are problematic to measure, control, and manage. The problem of maintainability is prevalent in the software industry and does not leave out the web services. However, certain models have been proposed for software maintainability. In this paper, we propose an iterative maintainability web service process model for effective mobile health care delivery in Niger state, Nigeria. The model would further be enhanced using the open shortest path Dijikstra algorithm to locate the closest healthcare facility and validated using the Cloud Network platform. Google Cloud will be used for easier DBMS and model deployment.**

Keyword— web service; maintainability; quick fix; iterative; model; mobile; healthcare; delivery.

I. INTRODUCTION

A web service can be described as a method of communication between two or more devices over the Web or Internet[1].Web service is also described as a new type of web applications with the capacity to hide implementation details behind web interfaces thereby providing a common standard mechanism for interoperable integration for disparate systems [2].It describes standard way of integrating applications on the web using Extensible Markup Language (XML), Simple Object Access Protocol (SOAP), Web Services Description Language (WSDL) and Universal Description Discovery and Integration (UDDI) which are open standards in an internetworked environment. While XML is used to tag the data, SOAP is mainly used for data transfer as a common message protocol in Web services. WSDL is used for describing the services available and UDDI is used for listing what services are available. Web services help people, business owners and organizations to communicate with each other and with their various clienteles. Organizations use web services to communicate and transfer data between each other without revealing the intricacies and details of the communication infrastructure hidden behind the firewall [3].

In traditional client/server models, such as Web server/Web page systems a graphical user interface (GUI) is provided which the client or user uses to communicate with the system, but in the Web services model there is no provision for a user GUI [4]. What Web services do is basically to share business logic, data and processes through a programmatic interface across the network [5]. The software developer can then add the web service to a GUI for example a web page to perform login function for the user.

Another major advantage of web services is the fact that they allow different applications written by different programmers and software developers communicate among themselves without the usually hectic time consuming coding process. Web services are also noted for their portability because they are not tied to any particular operating system or programming language. They are written in a common language which is the XML and this makes it possible for cross platform operations. For example, Java can talk with Perl; Windows applications can equally talk with UNIX applications [4].

A major issue however with web services as well as other software is the issue of maintenance. Maintainability of software as opposed to that of hardware and other products differs, and this makes maintaining software products very difficult. Other products are properly tested and already have a pre-defined maintenance procedure which if strictly followed prolongs the life span of the product [6]. This is however not the case with software products and web services.

The paper is organized into the following sections: Section 1 is the introduction of the work, looking generally at the concept of maintainability. Section 2 discusses the basic concept of web services and maintainability Section 3give the review of relevant related works. Section 4 discusses existing maintainability process models. Section 5 discusses the proposed Iterative Maintainability Web Service Process model, section 6 discussed model validation procedure while section 7concludes and proposes our next research direction.

II. WEB SERVICES AND MAINTAINABILITY

Web services also known as application services forms the basis of most web applications and many organizations are heavily dependent on their use in running their day to day operations. This gives rise to maintenance issues and many of these organizations want to greatly reduce the amount of money spent for the maintenance of these web services[6]. Most organizations have come to realize that the cost of

978-1-4799-2017-4/13/$31.00 ©2013 IEEE

developing a new software system that makes use of these web applications is nothing compared to the cost of maintaining these services. Maintaining these web applications or services includes continuous extension, adaptation and fixing programming errors and bugs during usage [3]. Apart from cost, many organizations such as Health care providers and Software development companies also consider the time it takes to implement an extension to an existing functionality as a major issue[6]. Organizations also consider the ability of the maintenance process to help them adapt quickly to the ever changing market situations in a timely and economical manner. The ability of the maintenance process to also help them initiate new products and services is also a major factor [7].

Maintainability can be defined as a flexible software maintenance scheme that significantly reduces the long-term cost of software. Maintainability is not solely a property of a system but touches three different dimensions [3]: The skills of the organization performing software maintenance; technical properties of the system under consideration and requirements engineering. The skill of the organization performing software maintenance has to do with the organizational knowledge management, provision of adequate tools, software maintenance activities and qualification of the maintainers [3]. Technical properties of the system under consideration has to do with the maintainability factor of the system, its flexibility factor, the lines of code and how much wholesome changes can be applied to the entire system[8]. Requirements engineering factor refers to the process of formulating, documenting and maintaining the specified software requirements [9]. Requirements engineering is usually presented in the first phase of the development process providing a strategic and tactical approach in the maintainability analysis of a software engineering project.

Another factor that makes the maintainability of software necessary over its life time is software deterioration. It has been observed that a software or web service deteriorates or its performance degrades as changes are made to it [10]. It is also observed that a software will constantly need to be modified during usage and as a result the cost of maintenance if not properly done supersedes the cost of the actual software. So the major aim of software maintainability is to reduce the cost of maintaining the software to the barest minimum over its life time [11].

In the health care industry, especially in the case of emergency, communication is majorly based on radio frequency (RF) communication especially communication between the ambulance and the hospital [12]. In some advanced countries however, such as in Victoria-Australia, a computer aided dispatch system has been setup and it's in full operation [12]. The computer aided dispatch was enhanced with web services to control the overall operation of the system. Millions of medical and healthcare practitioners as well as patients all over the world are now using smart phones and the number of users are increasing daily [13]. The increasing use of these mobile devices gives healthcare organizations a good opportunity to improve efficiency, quality, patient satisfaction and speed of delivery using the mobile web applications. A system that took advantage of the mobile web applications is the iLink's m-Health Solution which used mobile web technology to develop applications for Windows Phone, Windows 8, iPhones, android and other smart phones [13]. The application relies heavily on the mobile networks with implementation through the cloud networks. The application helps to deploy medical care to patients by providing location of the patients as well as connectivity to clinical applications, tele-health as well as remote monitoring of the patient. These two systems have been implemented with great success; however major issues with the systems are the issue of maintainability of the patient's bio data and other clinical information. Most times the patients' records are not up to date, the doctors' locations are not updated, the new ambulance additions are not properly documented and these go a long way in affecting the effectiveness of the web service.

This paper proposes an iterative maintainability model that can be used to effectively and efficiently maintain mobile web services in the healthcare delivery especially in critical emergency scenario in Niger state, North Central Nigeria, West Africa. The proposed model will help in quick and effective database updates of medical and healthcare databases.

III. MOBILE HEALTHCARE WEB SERVICE IN ADVANCED COUNTRIES

Mobile web services have been used across the world and a typical case in view is that being used in Victoria-Australia. The Victorian system is currently considered as one of the best users of web services in the world to manage patients in case of an emergency [12]. The system makes use of web services to provide vital clinical information from the hospital to the ambulance or the emergency site in case of an accident. The system being driven by web service applications helps to intelligently locate and find the right ambulance, the closest hospital and the most qualified doctor around the vicinity. Figure 1 shows the full operation of the web service application been used. Using web service applications, the system overcomes the major challenge of interoperability between systems running on different platforms, using different programming languages and different operating systems.

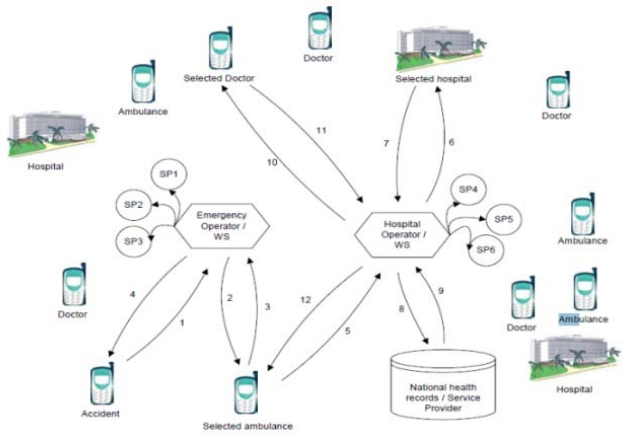


Figure 1. Comparative emergency system [1].

The system is fully automated and uses Mobile Web services (MWS) for the automation process. In case of an emergency, the first person that arrives at the scene sends a Short Message Service (SMS) to the dedicated short code which in this case is 000. The Short Message Service (SMS) goes directly to the emergency operator database, searches for the nearest ambulance and notifies them of the emergency and then searches the hospital database for the nearest hospital which the patient can be taken to and equally searches for the best available doctor to handle the case. On arrival at the scene the patient's bio data can be searched by simply using biometrics in this case Fingerprint. Biometrics generally is an automated recognition of a person using the person's physiological or behavioral characteristics [14]. Fingerprint biometrics is a biometric method of recognizing a person using his or her fingerprint. Once the patient is identified by biometrics, the clinical details automatically fetched from the National Health records service provider database. The data is then sent to the emergency worker to help administer first aid, after which it is sent to the selected hospital and doctor, who waits in anticipation of the patient. The system uses various web services to make the choices working in collaboration with the Mobile networks available.

A. Existing Mobile Healthcare Web Services

Nigeria is a Federal Republic comprising thirty-six states located in West Africa .It shares common borders with Chad, Cameroon, Benin Republic, Niger Republic and lies on the Gulf of Guinea on the Atlantic Ocean. Niger state is located in the middle belt of the country and it houses different ethnic groups such as the Nupe's, Gbagi's, Hausa's, Kuru's, Kamberi's, Kadara's, Jibo's and other minority ethnic groups such as the Yoruba's and Ibo's. In Nigeria like every other developing nation, the issue of correctly administering adequate and timely healthcare delivery is of paramount importance [15].Niger State is said to be one of the poorest states in Nigeria, this makes the deployment of adequate and timely healthcare system difficult for the residents [15]. Quality healthcare delivery as well as value added service can be achieved through the adoption of the proposed iterative maintainability model for mobile health care using the National Health Insurance Scheme as the backbone.

The National Health Insurance scheme (NHIS) can be used as the National health database provider, while the mobile networks serve as the providers. The first response team in the case of emergency especially accident is the Federal road safety corps (FRSC). A dedicated phone number is setup which can be called or an SMS system which people can call or send SMS to. The web service application notifies the closest office of the FRSC about the accident, chooses the nearest hospital and notifies the doctor of an incoming accident case. In this way the system can effectively use the web services to save the patient's life.

The major challenge of this system especially in the developing nation is that of poor coverage of the mobile network providers. However, a challenge common to both the developed and developing nations is that of maintainability of the system. This is the challenge this paper seeks to address by proposing a maintainability model based on the Iterative maintainability Web service model.

IV. EXISTING MAINTAINABILITY PROCESS MODELS

Maintenance in software mainly involves software development and requires special technical know-how and skills in order to carry it out [16]. It is however discovered that many times, these activities are carried out without requirements or appropriate documents for the design and problem of difficulty in understanding the old program code [16].These critical factors give rise to the need to have standardized maintenance models. Several models have been developed for software maintainability. There are different approaches and models used to maintain software and by extension web services, three of the common ones are:

A. The Quick Fix model

This model is similar to the agile process model. The main goal of this model is to identify the issue or problem and fix it immediately or as soon as possible. This model proffers immediate solutions without considering the long term effects of the action [15]. This model gets the job done quickly and at a usually low cost but the effects on the long run might not be too healthy for the system [5].

B. The Reuse oriented model

This model considers part of the existing program component that can be reused. It identifies parts of the old system with potential for reuse, analyzes and understands the system parts and then modifies the old system component to meet the new requirements, before finally integrating the modified part into the system to create a new system [17].

C. *The Iterative Enhancement model*

This works on the assumption that that any change made to a software or web service application during its life cycle can make up an iterative process which can be used for the maintainability of the system [17]. The Iterative process model has three [6] stages as stated below:

- *Analysis stage*
- *Modifications are proposed and classified*
- *Implementation stage*

Figure 2 represents the process for the iterative model adapted in this work

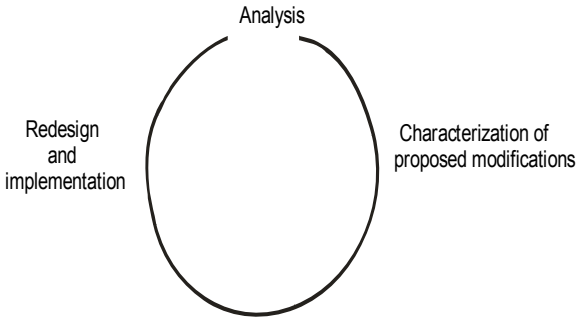


Figure 2. Standard Iterative process model [17].

V. PROPOSED ITERATIVE MAINTAINABILITY WEB SERVICE PROCESS MODEL

A critical factor in the maintainability process model is to determine firstly, what needs to be modified, modify to satisfy the new requirement and maintenance objectives. The modifications are then certified to make sure it does not affect the other portions of the system that needs no modification. This paper proposes a model to maintain the web service in the mobile health care delivery using an Iterative maintainability Web service model. The iterative model was chosen because it satisfies the maintenance process for web services. Quick fix was not adopted because it does not consider the overall effect on the system. The implementation of the quick fix approach is relatively fast especially when making changes to the system code but the change could have an adverse effect on another section of the system on the long run, which might not be considered on the immediate once the error has been fixed. Reuse was also not chosen because the process requires more time to complete. The major advantage of the iterative method is that it is fast and cheaper compared to reuse method. This characteristic meets the basic requirement of maintainability. Figure 3 shows our iterative maintainability model for mobile healthcare web services.

In the proposed model, new requirements are stated and defined. This is done by the doctors and researchers. The new requirements could be the discovery of new ailments/symptoms, addition of new doctors, their locations and specialization, addition of new ambulance and new healthcare delivery staff. These new requirements are added

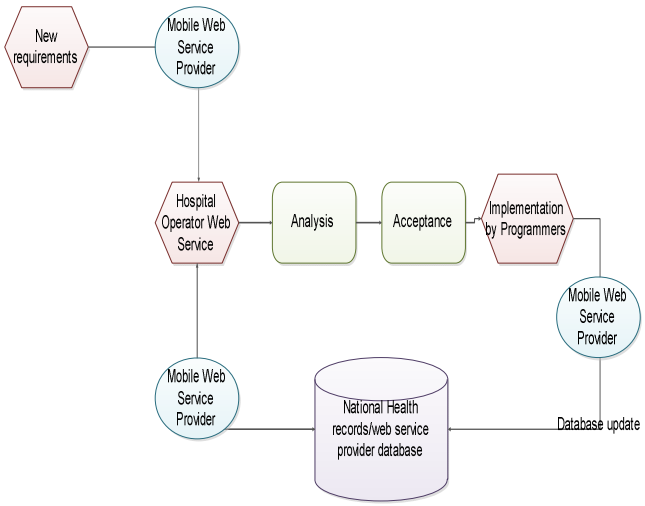


Fig. 3: Proposed Maintainability model using iterative process for health care delivery.

directly to the national Health records database through the web service interface after analysis by a team of experts via the web interface. The analysis will include the nature of the new ailments, the relevant or probable symptoms, the authenticity of the qualifications of the new doctors and staff. After verifying the results of the analysis, it is then accepted and handed over to the programmers via the web service interface. The programmer in turn modifies and updates the database immediately and the new alteration is uploaded with minimal effect on the performance of the existing system. The iterative nature of the model using the web service interface makes the process fast and deployment easier. Also new requirements can continually be added, analyzed and updated.

VI. VALIDATION OF THE PROPOSED MODEL

Validation is a process of checking that the product designed satisfies or fits the intended use or in other words answers the question of "Are we building the right product?" [18]. It also determines the degree to which a model, simulation and their associated data are an accurate representations of real world from the perspective of the intended users [18].

The developed model will be validated using the Cloud Network platform. Google Cloud platform will be used, which supports DBMS and is relatively easier for model deployment. The process of validation involves installing a 3G MODEM on the laptop which has the developed web application. The 3G modem is to provide internet connectivity to the laptop which will be used to connect to the Google Cloud App Engine. Platform as a service (PAAS) was used on the Google cloud platform. A new user will be created on the Google Cloud Console; the App Engine Admin Console will be activated to enable Source Push-to-Deploy button. An authentication token will then be obtained together with the password. This will be used each time there is need for deployment and uploading to the database. The database is then created and uploaded to the Google Cloud App Engine. The full App is then deployed on the cloud. Data obtained

from selected hospitals in Niger State will be uploaded into the database for the validation process. The model will be tested and the results compared to that of existing models, which will be analyzed and documented. Google Cloud will be used because it is cost effective and offers excellent support and after sales follow up.

VII. CONCLUSION AND FUTURE WORK

In software development life cycle, the maintenance process is an ongoing process and performing this task save cost and prolongs the life span of the software or web service in use. In this paper, a comprehensive model was presented using the Iterative maintainability web service process model. In this model, once a new requirement is determined, it is immediately displayed on the web service interface by the doctors, researchers or health workers. Once displayed, it is acted upon quickly and once an agreement is reached, the programmers modify and update the database appropriately. The iterative nature of the model makes it easy for users to send their findings which are acted upon quickly. The iterative model enhances quick maintainability of software using web services. The model would further be enhanced using the open shortest path Dijikstra algorithm to locate the closest healthcare facility, implemented and deployed using cloud computing. Deployment within the cloud provides a relatively cost effective platform for hosting the database and also enhances the mobility and maintainability of the software. The model will be evaluated by comparing it to existing models available in Niger State, Nigeria. Future research works will investigate issues of security, authentication and privacy in mobile healthcare web services in sub–Saharan African continent.

REFERENCES

[1] S. El-Masri, “Mobile Comprehensive Emergency SystemUsing Mobile Web Services” .The Second International Conference on Innovations in Information Technology,vol. 5, pp. 54-63, 2005.

[2] D. Basci, S. Misra, “Data Complexity Metrics for XML WebServices”, Advances in Electrical and Computer EngineeringJournal, vol. 9, pp. 9-15, 2009.

[3] P. Markus and D. Florian, “How to effectively define and measure maintainability”, Software Engineering Journal,vol.6 , pp. 303-316, 2008.

[4] K. Poonkavithai and G. Zayaraz, “Test Sequences for Web Service Composition using CPN model”. A journal of Computer Engineering and Intelligent Systems, vol. 3, pp. 32-41, 2012.

[5] A. Armstrong and G. Takang, , “Software maintenance: concepts and practice”, International Thomson Computer Press, vol. 14, pp. 219-223, 1996.

[6] B. Manfred, F. Deissenboeck and P. Markus, “Demystifying Maintainability”, Software Engineering Journal), vol. 3, pp. 5–39, 2004

[7] G. M. Berns, “Assessing software maintainability”.ACM Communications Journal, vol. 1, pp. 27-3, 1984.

[8] F. Deißenböck, S. Wagner, M. Pizka, S. Teuchert, J. F. Girard, “An Activity-Based Quality Model for Maintainability”, Submitted to Int. Conf. on Software Maintenance, Paris, vol. 6, pp. 24-30, 2007

[9] M. Fowler, “Who needs an Architect?”, IEEE Software Engineering Journal, vol. 20, pp. 11-13, 2003.

[10] L. Rikard, “Measurements of Software Maintainability”, Journal of Software Maintenance: Research and Practice of Software, vol. 61, pp. 6-13, 2002.

[11] K. K. Aggarwal, Y. Singh, and J. K. Chhabra, "An Integrated Measure of Software Maintainability", In Proceedings of Annual Reliability and Maintainability Symposium, IEEE, International Journal of Management and Systems IJOMAS, vol. 20, pp. 12-18, 2002

[12] http://www.ambulancevic.com.au/opservices/communications.html last accessed 12 March 2012

[13] http://www.ilinksystems.com/Services/Mibility/FeaturedSolutions/Healthcare.aspx last accessed 24 July 2013

[14] http://www.scientificamerican.com/article.cfm?id=are-ones-fingerprints-sim last accessed 31 July 2013

[15] I. K. N. Chiazor, “Design and Implemention of a hospitaldatabase management software in Enugu”: A MastersThesis in computer science, University of Nigeria, Nsukka, unpublished, 2008

[16] P. Stafford,,Software Maintenance as Part of the Software Life CycleComp180: Software Engineering, Journal of Web Semantics, vol. 4, pp. 1-4, 2011

[17] K.KAggarwal and S. Yogesh, “A Software Reliability Growth Model for Three-Tier Client Server System”. International Journal of Software Engineering (IJSE), vol. 2, pp. 13-24, 2011

[18] U.S Department of Health and Human Services, Food and Drug Administration, “General principles of software validation; final guidance for industry and FDA staff”, vol.1, pp. 11-15, 2002