An Enhanced Application for Securing File Transfer Over Android Devices

Bioku Idris, Dr. Musa Sule Argungu, and Dr. Muhammad Saidu Ailero
Department of Computer Science,
Faculty of Physical Sciences,
Kebbi State University of Science and Technology,
Aliero, Kebbi State, Nigeria.
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ABSTRACT
This study proposes the development of an Android application for secure file transfer. The application will utilize a user-friendly, easy-to-set-up, and open-source file-sharing technique. It aims to provide users with the ability to easily host, store, backup, and retrieve data with high performance, ensuring file accessibility at any time without limitations. The motivation stems from users' lack of control and difficulty in remembering file names, contents, and locations, increasing the risk of data loss. The study will employ the Structured System Analysis and Design Methodology (SSADM). The resulting Android application is expected to enable users to share files via cloud networks conveniently. This application is intended to benefit various organizations, including enterprises, shopping malls, supermarkets, waste companies, and power holding companies.

INTRODUCTION

File sharing is a relatively new technological advancement which has been steadily taking over more and more market share in the past three years. The file sharing technique makes users share files among each other with ease, is easy to setup, and is open source. File sharing is publicized as the next major step for all forms of typical information technology use. From businesses to non-profit organizations, to single users, there seems to be various applications which can use file sharing or storage in daily computer usage, to offer a better, faster, and smarter way to share important document. Many file sharing systems are available sharing of files between computers, such as Napster, Gnutella, and Free net over the internet. Most of the internet traffic is due to file sharing systems. Napster uses a server to communicate between the users, and each user should contact the server in order to get the data. Gnutella, however, depends on the client/server approach where the peer sends a query to all peers in the network.

This chapter will discuss the background, statement of problems, aim and objectives, significance, scope, limitations, and definitions of technical terms, providing the necessary foundation for the remaining parts of this study.

BACKGROUND OF STUDY

File sharing has been a means of distributing or providing access to digitally stored information, this information could be computer programs, multimedia files like audio, images and video, documents, or digital books. The Phrase "cloud computing" is defined as a framework programming application. Cloud computing is on high request and saves a lot of cost in processing

and adaptability, high-accessibility, and decreased data usage. Amazon's Elastic Compute Cloud (EC2) is a case of Infrastructure as a Service (IaaS) stage. It offers fundamental foundation segments, for example, CPUs, memory, and capacity. Google App Engine is a case of Platform as a Service (PaaS) stage. In Distributed computing stage, Cloud server is a physical server. Cloud computing is a technology that utilizes the web and central remote servers to keep up applications and data storage. One significant challenge is the manner by which to move these conventional applications to the cloud. This research focuses on the migration of specific flies of any size, from the local storage device to a cloud-based system with more security can be easily accessed any part of the world.

STATEMENT OF PROBLEM

This section highlights the problems with traditional file sharing, management, and storage methods like manual filing. Key issues identified are users having limited control and knowledge about shared files, including the risk of viruses. Additionally, users often struggle to remember file names, contents, and storage locations, leading to an increased risk of data loss. The text also mentions potential irregularities during file sharing, such as connectivity problems, device compatibility issues, and human errors. The proposed Android File Sharing Application aims to address these challenges by providing an effective way to share and manage files over the internet, allowing authorized users to easily access and manage uploaded files from anywhere in the world.

AIM AND OBJECTIVES OF THE STUDY

The aim of the study is to enhance application for securing file transfer over android device. In achieving this aim, the following specific objectives were laid out as follows to develop application software that will:

1. Simplifying data handling: Enabling users to easily host, store, and back up data, with high-performance computing capabilities for easy retrieval.
2. Guaranteeing accessibility: Ensuring seamless file access across devices, eliminating limitations imposed by device compatibility
3. Improving availability: Making files readily accessible to the end-user at any time, overcoming the availability challenges often encountered in traditional file-sharing methods.

SIGNIFICANCE OF STUDY

This research work enhanced to provide a means to transmit files (data/video) from one system to another or a group of systems connected to a hub or connected via an Ethernet straight-through cable. It also provides a cost-effective, secured, safe and faster means to transfer files from one device to another. It is also a secured and effective way of transferring the results of students in the department to the office of the dean. It is an improved means for proper administration of students in the department, to eradicate the issues associated with missing results in the department, and to also save cost.

This study of immense benefit to other researchers who intend to know more in this study and can also be utilized by non-researchers for further research. This study contributes to knowledge and could serve as a guide for other researcher.

SCOPE AND LIMITATIONS OF STUDY

The scope of the research is focused on An Enhanced application for securing file transfer over Android device, which will represent as a platform for file sharing, information storage and dissemination.

During the course of this study, many things militated against its completion, some of which are:

Scope

- Focus: This study will specifically focus on the development and evaluation of an enhanced application for secure file transfer on Android devices.
- Technology: The study will primarily investigate and implement security measures within the context of Android's operating system and utilize relevant cryptographic algorithms.
- Users: The scope of this study will primarily consider individual users and small workgroups within an Android-based environment.
- File Types: While the application aims to support a wide range of file types, the primary focus will be on common file formats such as documents, images, audio, and video.

Limitations

- Platform Dependency: The application's functionality may be limited to devices running Android operating systems.
- Testing Scope: Thorough testing will be conducted on a limited number of Android devices and versions due to the vast diversity within the Android ecosystem.
- Real-world Threats: While the application will incorporate robust security measures, it may not be completely immune to all potential real-world cyber threats and vulnerabilities.

LITERATURE REVIEW

The proliferation of Android devices has revolutionized how we share and access information. However, traditional file-sharing methods over these devices often lack robust security measures, leaving sensitive data vulnerable to interception and unauthorized access. This literature review explores existing research and technologies related to secure file transfer on Android platforms, identifying key challenges and potential solutions for an enhanced application.

CONCEPTUAL REVIEW OF FILE SHARING

The widespread use of cloud storage in the last few years can be attributed to the existence of appealing applications such as file backup, data archival and file sharing. File sharing in particular, is implemented in different ways by distinct cloud storage services. With more people accessing their files online, an important part of file sharing today is done by taking advantage of cloud storage. This can be done through personal file synchronization services like Drop box (2021), Google Drive (2021), Microsoft One Drive (2021), Box (2021) or Ubuntu One (2021), which store users' data in the cloud.

These services have been extremely successful, as attested by the success of Drop Box, which has announced last April that it reached 275 million users (Drop box, 2021). These systems perform file sharing through dedicated application servers which are responsible for controlling access to the files as well as user group management, data reduplication, etc. It means that the security of the file sharing requires trusting not only the storage service (for instance, Drop box is built on top Amazon S3 (Drop box, 2021), but also these application servers.

THEORETICAL FRAMEWORK

The widespread use of Internet connected systems, and distributed applications have triggered a revolution towards the adoption of pervasive and ubiquitous cloud computing environments. These environments allow users and clients to purchase computing power according to necessity, elastically adapting to different performance needs while providing higher availability. Several web-based solutions, such as Google Docs and Customer Relationship Management (CRM) (Minqi et al., 2010) applications, now operate in the software as a service model. Much of this flexibility is made possible by virtual computing methods, which can provide adaptive resources and infrastructure in order to support scalable on-demand sales of such applications.

CLOUD COMPUTING

Cloud computing refers to the use, through the Internet, of diverse applications as if they were installed in the user's computer, independently of platform and location. Several formal definitions for cloud computing have been proposed by industry and academia. We adopt the following definition: "Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction" (Mell et al., 2010).

CLOUD COMPUTING ARCHITECTURE

Cloud computing architecture is based on layers. Each layer deals with a particular aspect of making application resources available. Basically, there are two main layers: a lower and a higher resource layer. The lower layer comprises the physical infrastructure and is responsible for the virtualization of storage and computational resources. The higher layer provides specific services. These layers may have their own management and monitoring system, independent of each other, thus improving flexibility, reuse and scalability.

CLOUD COMPUTING DEPLOYMENT

According to the intended access methods and availability of cloud computing environments, there are different models of deployment (Mell et al., 2011). Access restriction or permission depends on business processes, the type of information and characteristics of the organization. In some organizations, a more restricted environment may be necessary in order to ensure that only properly authorized users can access and use certain resources of the deployed cloud services. A few deployment models for cloud computing are discussed in this section. They include private cloud, public cloud, community cloud and hybrid cloud, which are briefly in the upcoming section.

EMPIRICAL REVIEW OF RELATED LITERATURE

In this section, we present related works in the fields of security, file systems and trust in the cloud.

Security in the Cloud

A number of technologies have been employed in order to provide security for cloud computing environments. The creation and protection of security certificates is usually not enough to ensure the necessary security levels in the cloud. Cryptographic algorithms used with cloud applications usually reduce performance and such reduction must be restricted to acceptable levels (Takabi et al., 2010).

METHODOLOGY ADOPTED

The structured system analysis and design methodology (SSADM) was adopted for the analysis, an enhanced system. Structured systems analysis and design methodology (SSADM) is a set of standards for systems analysis and application design. It uses a formal methodical approach to the analysis and design of information systems.

SSADM follows the waterfall life cycle model starting from the feasibility study to the physical design stage of development. One of the main features of SSADM is the intensive user involvement in the requirements analysis stage. It is a part of requirements gathering and consists of well defined stages, steps and products. The techniques used in SSADM are logical data modeling, data flow modeling and entity behavior modeling.

a) Logical Data Modeling: This involves the process of identifying, modeling and documenting data as a part of system requirements gathering. The data are classified further into entities and relationships.
b) Data Flow Modeling: This involves tracking the data flow in an information system. It clearly analyzes the processes, data stores, external entities and data movement.
c) Entity Behavior Modeling: This involves identifying and documenting the events influencing each entity and the sequence in which these events happen.

PROBLEM IDENTIFICATION USING SSADM

The SSADM was used to discover some problems;

a) **Feasibility Study**: This assumes that the proposed project has been identified as a result of an exercise such as strategic planning and sets out to evaluate the various technical, organizational, financial and business options available. The aim is to establish the whether the direction and requirements of the project are feasible. The aim is to evaluate the feasibility of the proposal, involving an analysis of the problem and determination of the best solution; usually a range of potential solutions are presented.

b) **Investigation of the Environment:** The process of identifying, modeling and documenting the data requirements of the system being designed. The result is a data model containing entities (things about which a business needs to record information), attributes (facts about the entities) and relationships (associations between the entities).

c) Business System Option (BSO): A BSO defines the functional scope of a proposed solution. At its most basic level it consists of textual descriptions of those requirements satisfied by the solution. All BSOs must satisfy the minimum requirement as identified by user representatives.

ANALYSIS OF THE EXISTING SYSTEM

The operations of the Cloud Based File Sharing System were analyzed, and some drawbacks were detected which led to the initiation of the new Cloud Based File Sharing System. In the old system, users have little control over or even knowledge of the type of file being shared, orif it contains a virus. Also, users do not or sometimes don't remember the names of these files, the files contents, and their storage locations; this increases the risk of loss.

Weakness of the Existing System

The essential weakness faced with the conventional way of file sharing, management and storage techniques (such as manual filing or sharing of images, documents etc) is that users have little

control over –or even knowledge of the type of file being shared, orif it contains a virus. Also, users do not or sometimes don't remember the names of these files, the files contents, and their storage locations; this increases the risk of lost.

Technical Feasibility

There is availability of software, hardware and technical manpower for the development and running of the new system. Hence the system is technically feasible as the requirement can be met without stress and much financial input. The software and hardware requirements include an Integrated Development Environment for web based applications, a standard PC for running this application, a local server and an up to date web browser for testing. As a programmer, the researcher can provide these requirements with ease and as such, this project is technically feasible.

Analysis of the Proposed System

An overview of the proposed system flow chat has a relationship between an object to another just like the entity. Relationship diagram, the object relationship pair can be graphically represented by a diagram called entity relationship diagram (Entity Relationship Diagram). It is mainly used in database applications but now it is more commonly used in data design. The primary purpose of ERD is to represent the relationship between data object.

SYSTEM DESIGN AND IMPLEMENTATION

Objectives of the enhanced

The following are the objectives of the proposed Cloud Based File Sharing System design will;

1. Enable users to easily host, store and backup data, with high-performance computing easy to retrieve.
2. Ensure files accessibility without any limiting factor, example device compatibilities.
3. Make file available to the end-user at any point in time. Cloud computing offers availability difficulties experienced in the conventional way of file sharing.

Cohesion and Decomposition High level Model

Description: This is a cohesion and Decomposition High level Model

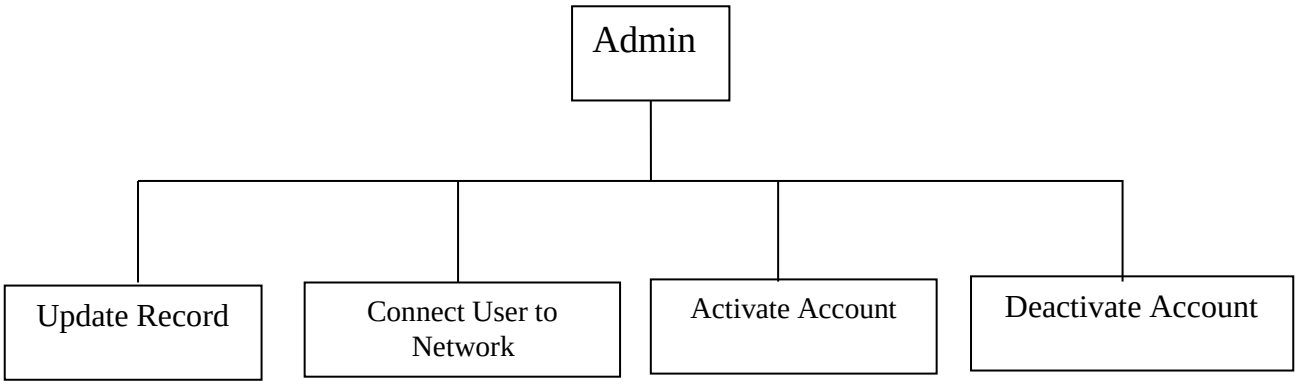


Figure 4.1: Admin User Privileges

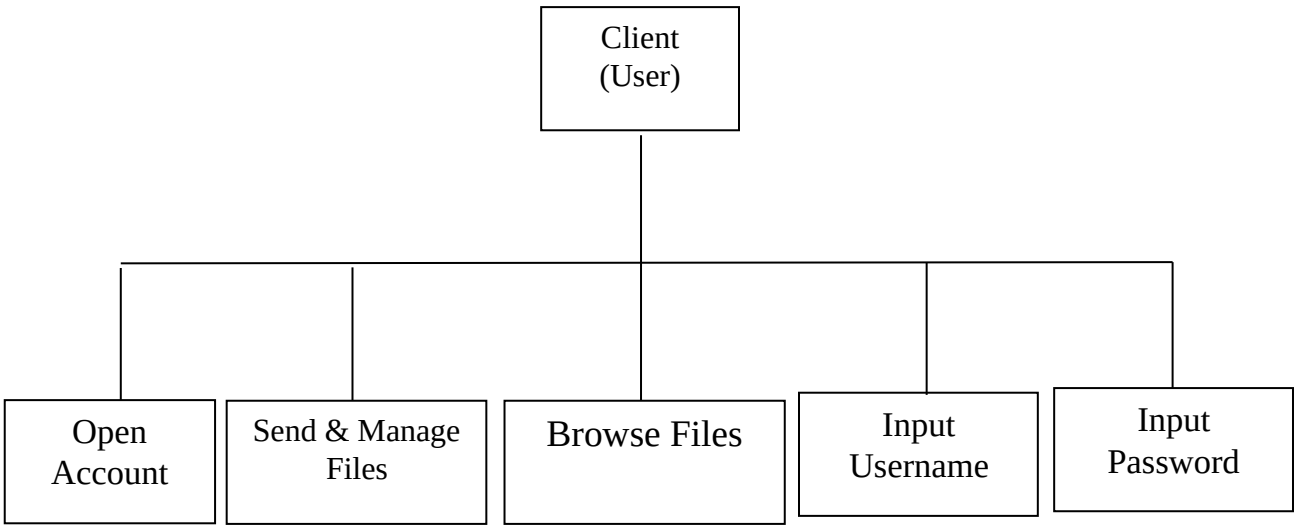


Figure 4.2: Client (User) Privileges

Control Center / Overall Dataflow Diagram

Description: This is a control center/overall dataflow diagram

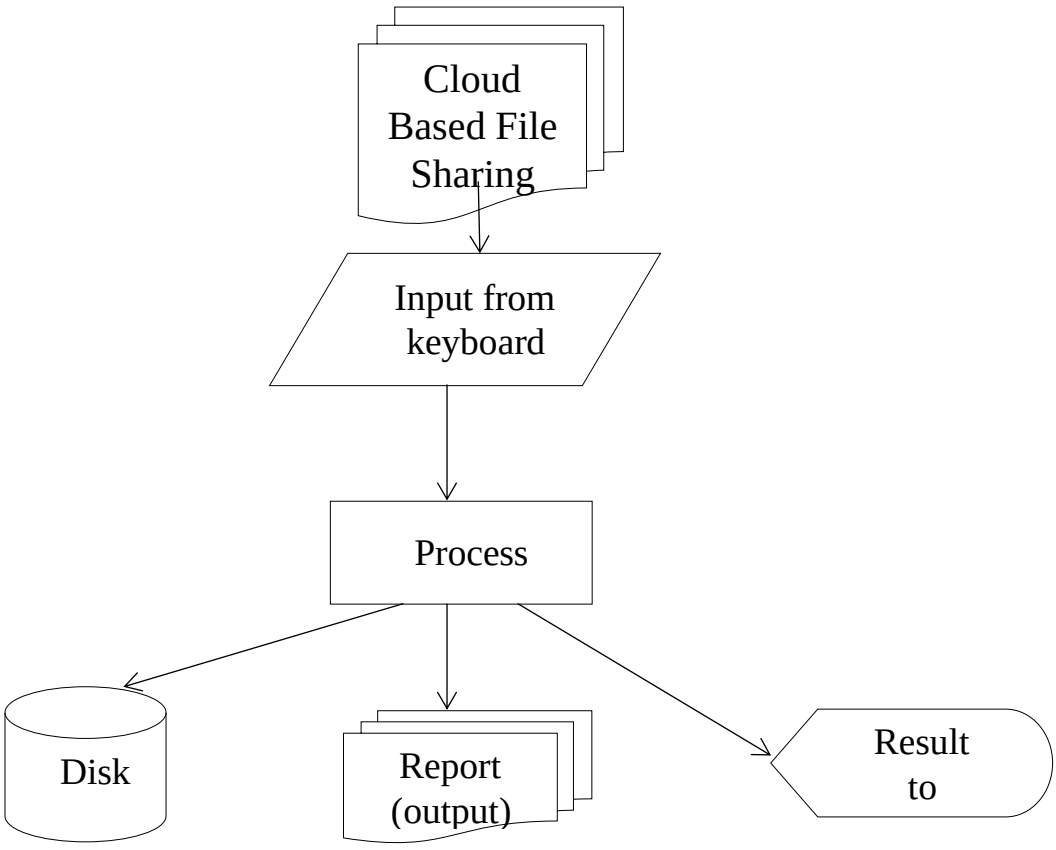
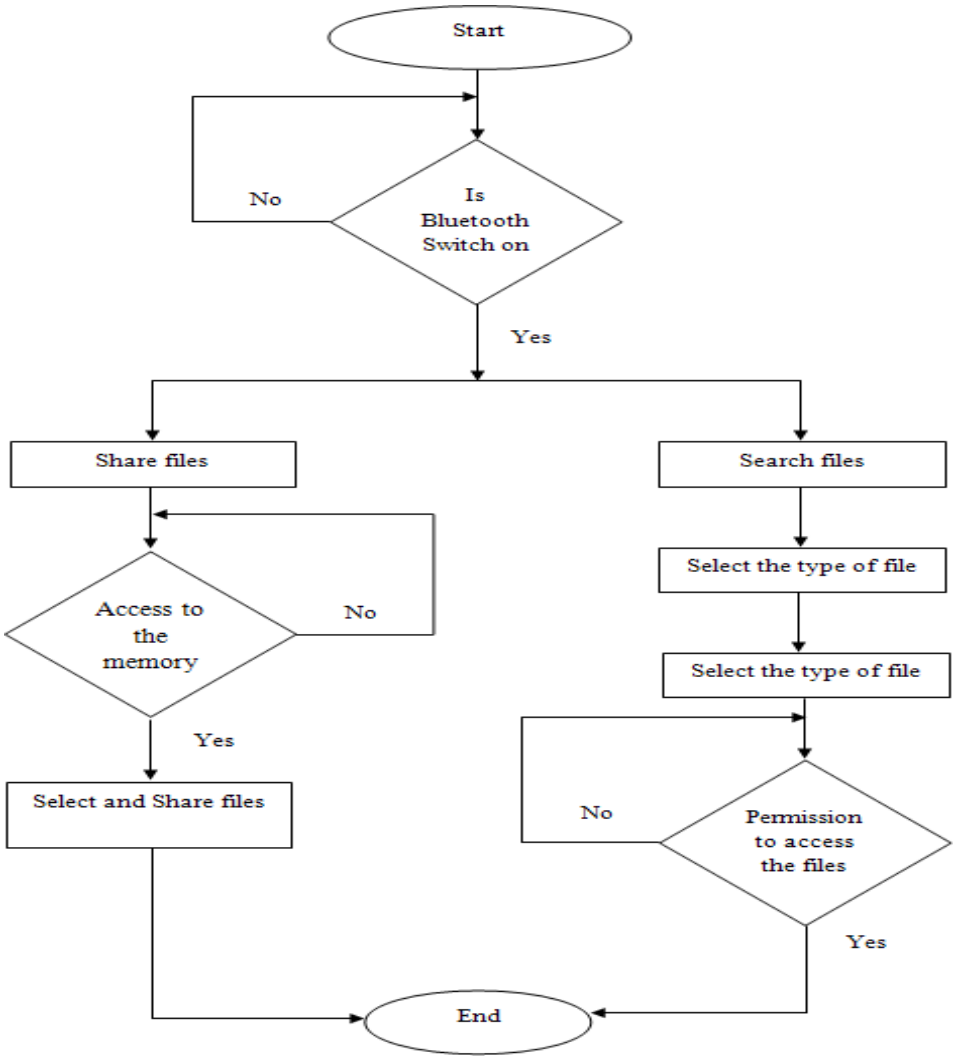


Figure 4.3 Control Center / Overall Dataflow Diagram



Proposed System Operation Flowchart
Description: The diagram below entails the proposed system operation flowchart

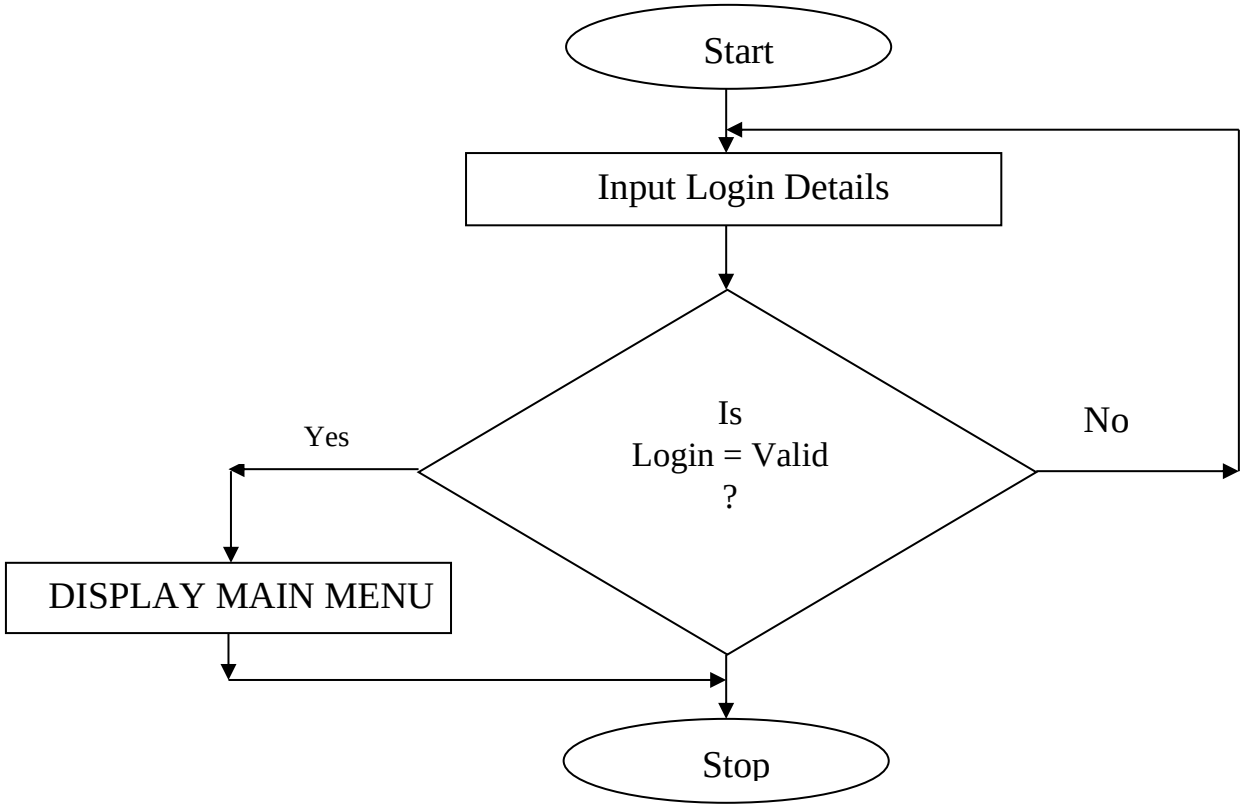
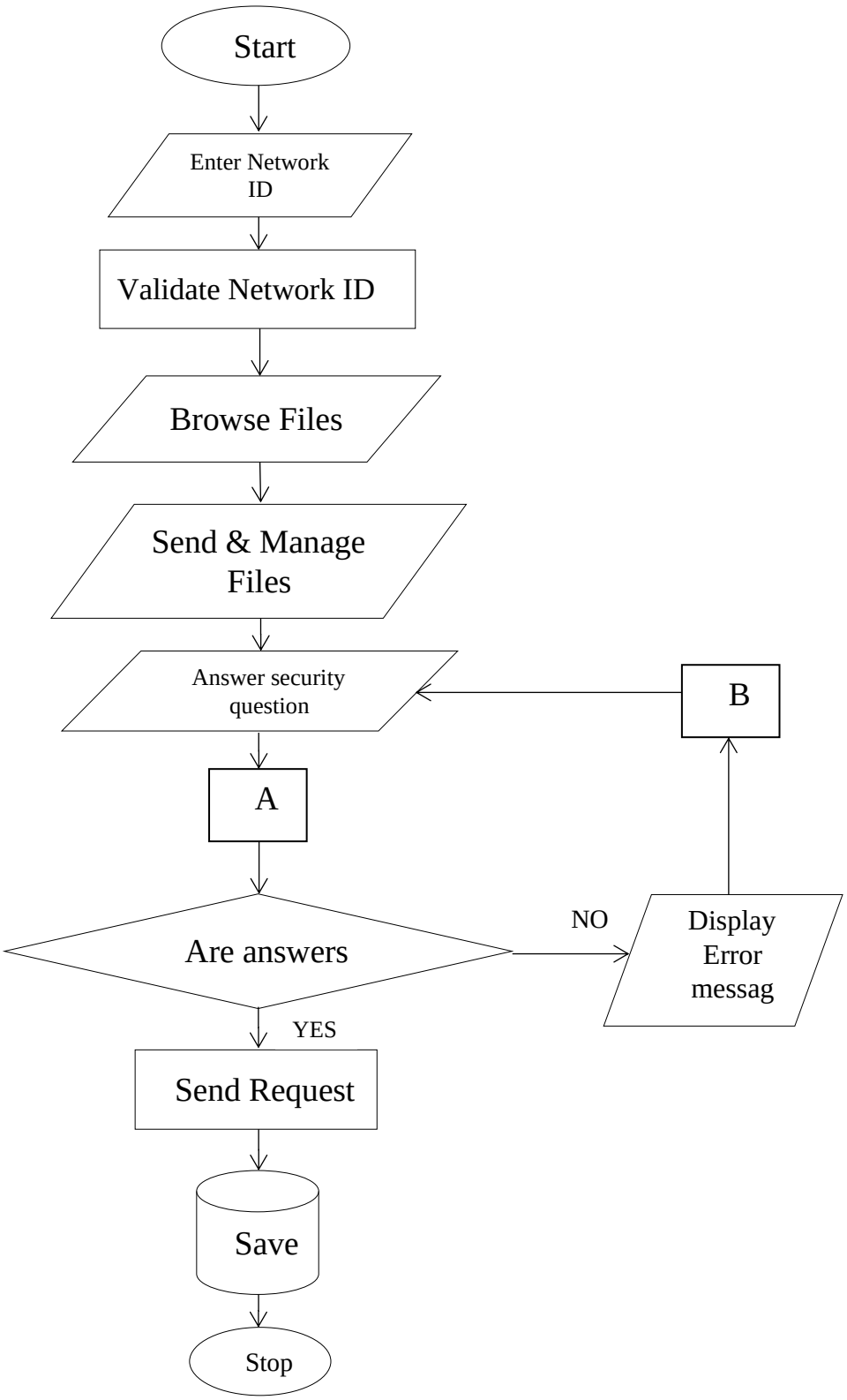
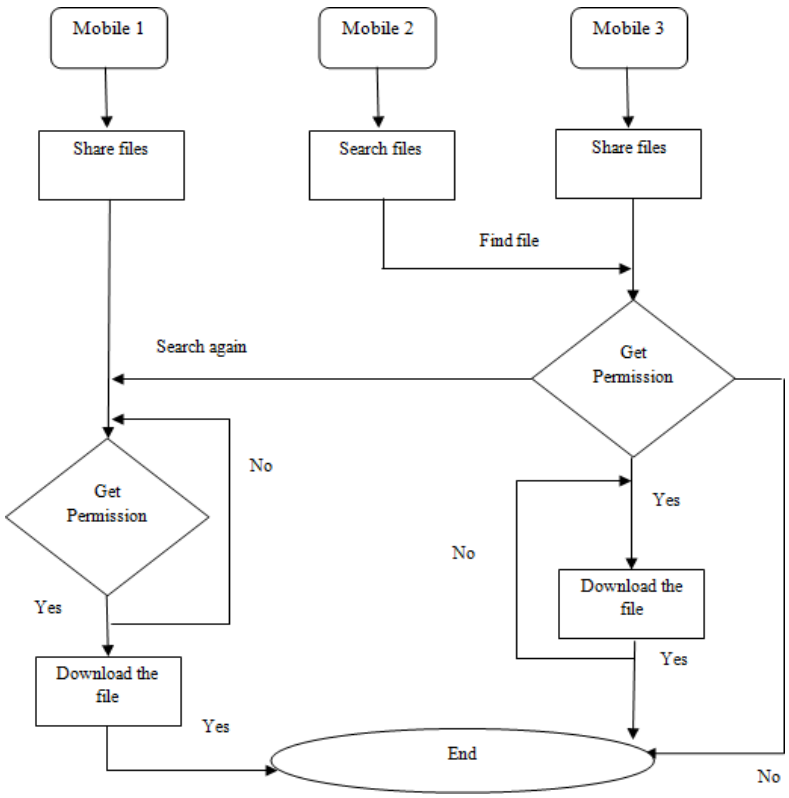


Figure 4.4: Security Design

Specification


Start
Enter Network ID
Validate Network ID
Browse Files
Send & Manage Files
Answer security question
B
A
Are answers
NO
Display Error messag
YES
Send Request
Save
Stop



IMPLEMENTATION TECHNIQUES

The software Implementation is a process carried out to make changes on the tested programs developed in the system. The software will be installed successfully if the hardware requirement and the software requirement are available. The following phase contains how the software was implemented successfully;

1) Coding: The coding system has been developed to meet the following main objectives;

- Enable users to easily host, store and backup data, with high-performance computing easy to retrieve.
- Ensure files accessibility without any limiting factor, example device compatibilities.
- Make file available to the end-user at any point in time. Cloud computing offers availability difficulties experienced in the conventional way of file sharing.

2) File conversion: During file setup it is necessary to convert the existing master file to a new page. This new form is the responsibility of the newly designed, which undergoes the process of converting the old system master file to a new one. System Conversion is a transformation process stage in system implementation at which the newly designed system is put in place of the old system by the organization after been tested and documented to prove that it is working. It is a significant milestone after which the ownership of the system officially transferred from the researcher (analyst) and the programmer to the end user.

SECURITY DESIGN SPECIFICATION

The security design specification is an authentication system that required a valid password to be input before using the proposed system. Below is a diagram of the Security Design Specification:

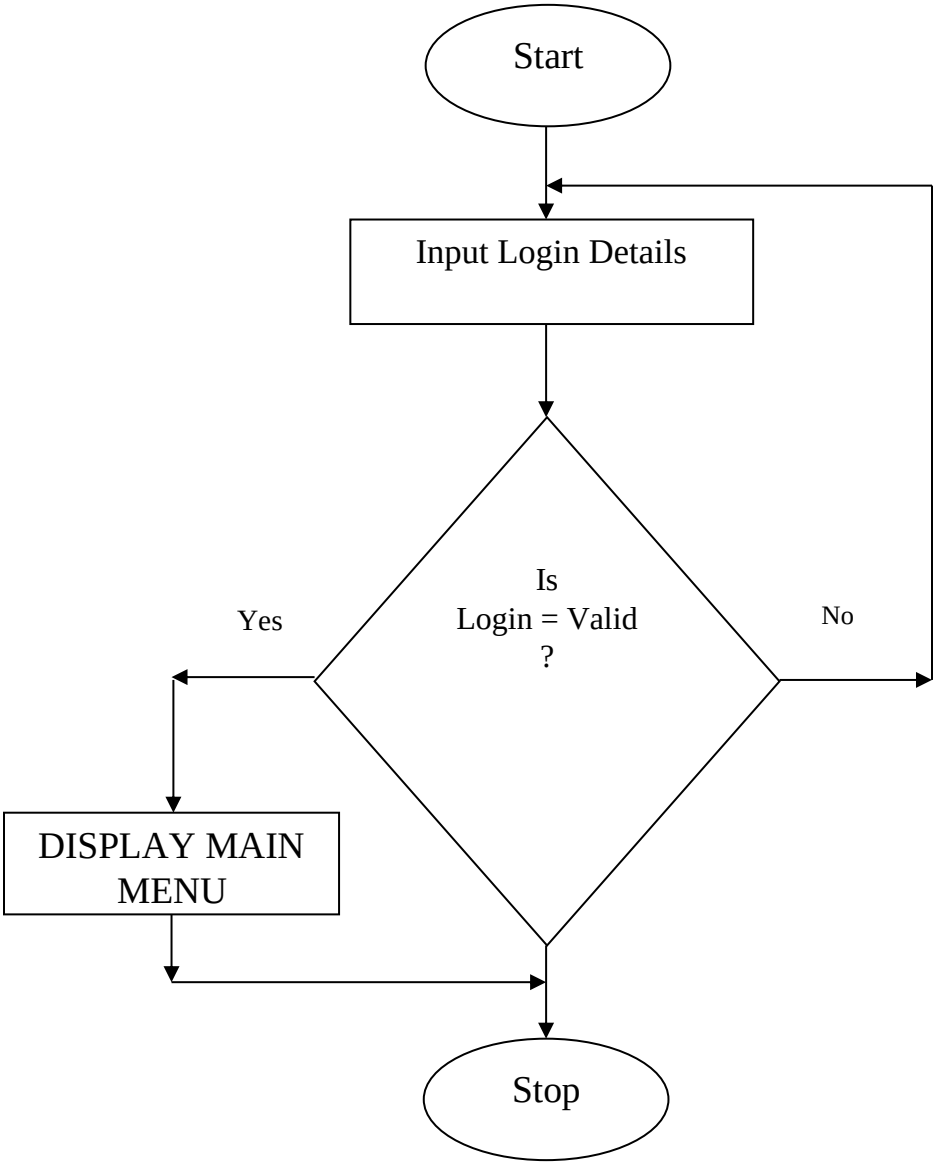


Figure: Security Design Specification

SUMMARY

This text describes file sharing as a growing technological advancement that enables easy, open-source file exchange for various users. It highlights the motivation for a new system: users' lack of control and memory regarding shared files, increasing the risk of data loss and virus exposure.

The study aims to design and implement an Android-based File Sharing Application with features for easy hosting, storage, backup, and retrieval of data with high performance and accessibility. The Structured System Analysis and Design Methodology (SSADM) is the chosen methodology, and the application will be developed using web programming languages (HTML, CSS, JavaScript, PHP, SQL, and jQuery) for platform independence. The expected outcome is an Android application allowing users to share files via cloud networks, benefiting enterprises and large companies.

CONCLUSION

In conclusion, the developed Android file-sharing application effectively addresses modern data transfer needs by offering a fast, secure, and user-friendly solution. Utilizing Wi-Fi Direct, it surpasses the limitations of Bluetooth with significantly higher transfer speeds and enables seamless sharing without internet. Its user-centered design ensures ease of use for all skill levels, promoting adoption. Robust encryption protocols guarantee data security and privacy during transmission. The application's broad compatibility across Android devices enhances its utility within the diverse Android ecosystem. Overall, this application provides a reliable and efficient tool for secure and intuitive file transfers, meeting the increasing demands for mobile data-sharing in both personal and professional settings.

RECOMMENDATION

Based on the findings, the following recommendations are hereby suggested that:

1. The file-sharing application for Android should incorporate continuous updates to enhance security protocols and stay resilient against emerging threats. Future versions should also support multi-platform compatibility, allowing seamless file sharing between Android and other operating systems such as iOS and Windows.
2. User feedback should be actively collected and analyzed to improve the application's interface and functionality, ensuring it remains user-friendly and responsive to evolving user needs.
3. Additionally, the app should include enhanced customization options, allowing users to configure their privacy and transfer settings according to their preferences. To improve accessibility, it should be optimized for a wider range of Android devices, particularly those with lower processing power and storage capacity, making the application more inclusive. Implementing these recommendations will enhance the application's robustness, expand its usability, and strengthen its position as a reliable tool for file sharing.

REFERENCES

A. Abdul-Rahman and S. Hailes, "A distributed trust model," In Proceedings of the 1997 New Security Paradigms Workshop, pp. 48-60, 1998.

A. Jøsang and R. Ismail, "The Beta Reputation System," In Proceedings of the 15th Bled Electronic Commerce Conference, pp. 17-19. June 2002.

A. Jφsang and S. J. Knapskog, "A metric for trusted systems," Global IT Security, pp. 541-549, 1998.

A. Marinos and G. Briscoe, "Community cloud computing," in First International Conference Cloud Computing, CloudCom, volume 5931 of Lecture Notes in Computer Science, pp. 472–484. Springer (2009).

Abidi, S.A.H., (1991). Information and Communication for development in Africa, Nairobi

Bessani, A., Correia, M., Quaresma, B., Andre, F., Sousa, P.: DepSky: Dependable and secure storage in cloud-of-clouds. ACM Transactions on Storage 9(4) (2013)

Bessani, A., Mendes, R., Oliveira, T., Neves, N., Correia, M., Pasin, M., Verissimo, P.: SCFS: a shared cloud-backed file system. In: Proceedings of the 2014 USENIX Annual Technical Conference – ATC'14 (2014)

Bing, T., Schubert, R, and Siu, C. (2001), Web Information Monitoring for competitive intelligence, Taylor and Francis Academic Information Journals, 33(3):235-251

Carter, Lemuria, and Belanger (2005), The Utilization of e-government services citizen trust, innovation and acceptance factors. France Information Systems 15 (1), 5-25.

Chen Kang and Zen WeiMing, "Cloud computing: system instance and current research," Journal of Software, pp. 20(5):1337-1347. 2009.

Cohn, M. (2014). "Zoho Revamps Online Accounting Software". Accounting Today. Retrieved 29 January 2014.

Connolly,T., Begg, C., (2001), Database Management Information Systems

Debons, L., (1988). The right to access of information: A paper presented at theSCESCAL XI Zomba, Malawi Library Association, p. 8

Donna, O. (2019). "What is horizontal portal? definition and meaning". BusinessDictionary.com. Retrieved 8 August 2019.

Enrado, P. (2000). Staff and patient, Room and Resource scheduling systems, Healthcare

Grammatikou, M ., Stamatelopoulos, F., and Maglaris, B. (2003), Distributed information system architecture for healthcare.

H. Takabi, J. B. D. Joshi, and G. Ahn, "Security and Privacy Challenges in Cloud Computing Environments," IEEE Security and Privacy, vol. 8, no. 6, pp. 24-31, Nov./Dec. 2010, doi:10.1109/MSP.2010.186.

Harpreet, S.R. (2002),Transferring data between Heterogeneous databases using the web.

Hosea, (1995) Chapter 4, Verse 6, (King James Version).

http://www.healthcareitnews.com/new

Huan-Chung Li, Po-Huei Liang, Jiann-Min Yang, and Shiang-Jiun Chen, "Analysis on Cloud-Based Security Vulnerability Assessment," 2010 IEEE 7th International Conference on e-Business Engineering (ICEBE), pp. 490-494, 2010.

Joch, A. (2000), Take the pain out of patient scheduling, Physician and Sport Medicine.

Johnson, R. and Mehra, S. (2002), Best practice complaint management, Academy of management Executive, 16(4): 145-254.

Joseph M. Hellerstein, et al (2007), Architecture of Database System.

K. Popovic and Z. Hocenski, "Cloud computing security issues and challenges," MIPRO, 2010 Proceedings of the 33rd International Convention, pp. 344-349, 24-28 May 2010 URL: http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=5533317&isnumber=5533310.

Kai Hwang, Sameer Kulkareni, and Yue Hu, "Cloud Security with Virtualized Defense and Reputation-Based Trust Mangement," 2009 Eighth IEEE International Conference on Dependable, Autonomic and Secure Computing (DASC '09), pp. 717-722, 2009.

Kai Hwang, Sameer Kulkareni, and Yue Hu, "Cloud Security with Virtualized Defense and Reputation-Based Trust Mangement," 2009 Eighth IEEE International Conference on Dependable, Autonomic and Secure Computing (DASC), Chengdu, pp.717-722. China 2009.

Laudon, K. C., Laudon, J. D., (2002), Management Information Systems, Organization and technology.

Lee, S.M. and Ssllani, A. (2001), A decision support system for health care services,Hospital management Quarterly, 22(3):64-70.

Li Xiaoqi, Lyu M R, and Liu Jiangchuan. "A trust model based routing protocol for secure AD Hoc network," Proceedings of the 2004 IEEE Aerospace Conference, pp. 1286-1295. 2004.

M. Miller, Cloud Computing – Web-Based Applications That Change the Way You Work and Collaborate Online, Que Publishing, Pearson Education, Canada 2008.

Michael, S. (2010). CPA Technology Advisor. "Building Strategy: How Workflow, Document Management and Portals Work Together".

Michael, S. (2010). CPA Technology Advisor. "Building Strategy: How Workflow, Document Management and Portals Work Together".

Minqi Zhou, Rong Zhang, Dadan Zeng, and Weining Qian, "Services in the cloud computing era: a survey," Software Engineering Institute. Universal Communication. Symposium (IUCS), 4th International. IEEE Shanghai, pp. 40-46. China. 978-1-4244-7821-7 (2010).

N. Santos, K. Gummadi, and R. Rodrigues, "Towards Trusted Cloud Computing," Proc. HotCloud. June 2009.

Nielsen, B. (1994), Management Information Systems, Michigan, U.S.A.

Oddi, A., and Cesta, A. (2000), toward interactive scheduling systems for managing Medical Resources: Artificial intelligence in medicine, 20(2): 113-138.

P. Mell and T. Grance, "Draft nist working definition of cloud computing - v15," 21. Aug 2009.

P. Mell and T. Grance, The NIST Definition of Cloud Computing (Draft). National Institute of Standards and Technology. http://csrc.nist.gov/groups/SNS/cloud-computing.2009. 30 may 2011.

Qingsong Wei, Bharadwaj Veeravalli, Bozhao Gong, Lingfang Zeng, and Dan Feng, "CDRM: A Cost-Effective Dynamic Replication Management Scheme for Cloud Storage Cluster," 2009 IEEE International Conference on Cluster Computing (CLUSTER), pp. 188-196, 2010.

Rivest, R.L., Shamir, A., Adleman, L.: A method for obtaining digital signatures and public-key cryptosystems. Communications of the ACM 21(2) (1978)

Rodrigue, J. (2018). American Institute of CPAs. "The Rage Surrounding Client Portals".

S. P. Marsh, "Formalising Trust as a Computational Concept", Ph.D. Thesis, University of Stirling, 1994.

S. Uppoor, M. Flouris, and A. Bilas, "Cloud-based synchronization of distributed file system hierarchies," Cluster Computing Workshops and Posters (CLUSTER WORKSHOPS), IEEE International Conference, pp. 1-4. 2010.

Samuel, D. (2010). Journal of Accountancy. "Client Portals: A Secure Alternative to E-Mail".

Samuel, D. (2010). Journal of Accountancy. "Client Portals: A Secure Alternative to E-Mail".

Saucer, J. and Bruns, G. (1997), Knowledge-based Design of scheduling system in industry and medicine, IEEE-expert, 12(1):24-31.

Sean, O. (2010). CPA Technology Advisor. "Building Strategy: How Workflow, Document Management and Portals Work Together".

Sean, O. (2010). CPA Technology Advisor. "Building Strategy: How Workflow, Document Management and Portals Work Together".

Seyle, T. (2014). "Expand Your Solo or Small Firm Practice Using Client Portals" (PDF). Law Practise Today. Retrieved 29 January 2014.

Seyle, T. (2014). "Expand Your Solo or Small Firm Practice Using Client Portals" (PDF). Law Practise Today. Retrieved 29 January 2014.

Stoner, J. (1995),Management 6th Edition, London, Prentice Hall

Susan, L. (2011). "What is vertical portal? definition and meaning". BusinessDictionary.com. Retrieved 8 August 2011.

T. Beth, M. Borcherding, and B. Klein, "Valuation of trust in open networks," In ESORICS 94. Brighton, UK, November 1994.

T. Dillon, Chen Wu, and E. Chang, "Cloud Computing: Issues and Challenges," 24th IEEE International Conference on Advanced Information Networking and Applications (AINA), pp. 27-33. Australia, 2010.

Vrable, M., Savage, S., Voelker, G.M.: BlueSky: A cloud-backed file system for the enterprise. In: Proceedings of the 10th USENIX Conference on File and Storage Technologies – FAST'12 (2012)