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MOBILE COMPUTING: AN APPROACH TOWARDS PAPERLESS OFFICE

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ABSTRACT

Most organizations productivity has been linked toward achieving paperless office, while paper documentation, routing and storage have indeed been associated with organization bureaucratic-bottlenecks, high operational and development cost. Several approaches such as workflow and document management software have been utilized to achieve paperless office (environment), but none has been able to implement remote access and computing to organization resources. Implementing an architectural framework that will achieve paperless environment through remote access and computing, bureaucratic freedom, increase revenue and reduce operational and developmental cost has long been an area of research consideration which inspired Proposed Enterprise Paperless Architectural Framework (PEPAF). Utilizing Unified Modeling Language (UML), the use view, structural and behavioral views were visualized. The cost-effective architectural framework proposed in this research paper handles the aforementioned dilemma utilizing mobile computing as an integral avenue for reduction of paper consumption within an organization by 50%.Prospective users are now aware of the range of critical solutions offered by mobile computing paradigm, the application executing both on the mobile device and synchronizing at the central repository (database) situated at the organization stationery boundaries.

Key words: Mobile computing, Paperless office, Paper, Mobile user and Mobile device

INTRODUCTION

In 2001, Seth Dawson, Chief Financial Officer (CFO) of a large industrial contractor in Baton Rouge, Louisiana needed to solve the problem of managing the large volumes of paperwork associated with running a self-performing construction company. As revenues climbed, so did the cost and burden of filing, routing, reviewing, and storing the associated documents. Logically, he decided to seek an outside solution from several leading providers of imaging and document workflow technology, including his existing accounting software vendor, Workflow (2009). Many Americans and conversely Nigerians are looking for cost-effective ways to conserve the environment. Receiving and paying bills online can make a big impact. Just consider: If every American household viewed and paid bills online, it could reduce solid waste in U.S. landfills by more than 800,000 tons a year and help curb the release of greenhouse gases by 2.1 million tons. This could also save an estimated 18.5 million trees a year, Fiserv **(**2012). Paper documentation and processing is the bureaucratic

bottleneck in Nigeria economy. It is the current trend from contract quotation to knowledge acquisition in Nigeria tertiary institution as well as regulatory weaknesses in governance, Garuba (2009).

The scenarios above depict the menace associated with human most pervasive invention "Paper". Paper is a thin material mainly used for writing upon, printing upon, drawing or for packaging. Paper is produced by pressing together moist fibers, typically cellulose pulp derived from wood, rags or grasses, and drying them into flexible sheets. Paper is a versatile material with many uses. The most common use of paper is for writing and printing. Paper is also widely used as a packaging material, in many cleaning products, in a number of industries, and for construction processes. In some Asian cultures paper, forms part of food ingredients, Jay (2010).

Despite its many uses paper documentation and processing has its drawbacks. These include: instant access to corporate documents and files even from remote locations is totally impossible; managing paper document/documentations is very difficult compared to the ease of electronic documentation, cost of courier services for paper delivery or paper documentation in transit, and utilization of valuable office space for file cabinets and boxes. The production and maintenance cost of paper documentations in many organization surpasses its benefits, as a result, there is a gradual decline in ecological system. Consequently, paper utilization is no longer a cost-effective corporate approach.

The goal of this paper is geared toward shrinking the consumption and usage of paper within an organization through a proposed cost-effective remote access model. In other to achieve this goal the under listed objectives were followed:

a. Discuss in details the infrastructures behind mobile computing,
b. Expose the concept of paperless office/environment,
c. Proposing an Enterprise Paperless Architectural Framework.

Review of Related Works

Robert (2007) proposed and implemented a Document Management Software (DMS) in achieving paperless environment within an organization utilizing several document management tools such as scanners, Optical Character Recognition (OCR) and image processor. The DMS was sub-divided to handle certain functionalities and process thereby reducing paperless processes. After close observation over a period of time, paper consumption and usage where on the steady decline, production and development cost also plunged. In conclusion, Robert agreed that DMS progressively reduces paper usage and cost variation though the limitation of his research was tied to the failure to achieve remote access and computing to this resource through this approach.

Several approaches; such as thesis, papers, short-communication and software has been proposed, adopted and developed in achieving paperless office. These approaches includes

a. **Document management:** Document management software allows the user to store electronic documents in a database for subsequent retrieval and sharing, and it can assign viewing and editing privileges to users. It helps manage the creation, distribution maintenance, organizing and storage of documents. It often includes scanning (converting paper documents to electronic format) and high performance storage. Keary (2009) points

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out that 'the weakest links in electronic document management are indexing, searching and retrieving'. This underpins that, although the selection of software is important in this regard, the application of appropriate expertise during the indexing phase is critical for finding electronic documents at a later stage, Keary (2009).

b. **Workflow:** Complex business processes typically include several operations, different levels of authority and documents or folders of information. Workflow software provides tools to automate the electronic workflow of documents and business procedures. It ensures that the correct document enters the database, routes each document to the appropriate person and ensures that approval is obtained at the right stages within the business process, monitoring each step of the process. Electronic workflow automates process control because it co-ordinates activities, role players, data/information and monitoring. Tracking and tracing of dynamic content and feedback are possible at any point in a document's life cycle. When applied correctly and not just automating inherently inefficient paper procedures, workflow is a catalyst for business process improvement (reengineering), defining new business rules, FHC (2000).

c. **Intranet:** Within an organization an Intranet creates a Web-enabled digital environment for the entire organization, providing services such as electronic mail, GroupWare and search engines. Through a standard Web browser the Intranet enables cross-platform information access, sharing and communication across traditional organizational boundaries, Ives (2001). Enterprise Information Portal (EIP) is the next natural step in the evolution of the organizational Intranet. It acts as a single point of access to internal and external information, enabling users to access disparate information sources throughout the organization. In larger organizations with distributed offices (i.e. the City of Johannesburg), an EIP can function as a unified corporate desktop that provides a personalized view of organizational information. The ultimate EIP integrates structured information (databases) and unstructured information (documents, items) with knowledge into a single, personalized top environment. EIP is acknowledged as an exciting development that provides an organizational platform to facilitate the paperless office, but is not detailed any further, Ives (2001).

d. **Enabling technologies:** Documents have to be put into a computer-readable format before they can be stored electronically. Enabling technologies that assist in the electronic management of documents include scanners that use image technology. Information in paper medium is converted to digital information and can be stored in multiple media such as microfilm, tape, disk flash drive, mobile devices, etc. Flat platen (bed) scanners are usually used for smaller documents (up to A3), while drum scanners are used for large (A0) sized documents. Multiple feed scanners are useful when working with multiple page documents and large volumes. The digital camera is another image-entry alternative especially useful for capturing images in fragile bound

materials, although it is less effective for large volumes. Optical Character Recognition (OCR) technology electronically recognizes characters or text automatically and can be used to convert scanned documents (images) to full text documents. It is particularly useful because it enables full-text indexing and searching. OCR and neural network systems are particularly interesting developments because they develop their own rules and can learn and relearn to provide solutions in the areas of data analysis, pattern recognition, data processing and electronic imaging. The integration of Electronic Document Management Systems (EDMS) are predicted to include all the technology functions related to scanning, indexing, modifying, processing, storing and retrieving of documents, Keary, (2000) and Tarsus(2001).

Several approaches (such as document management software and workflow software) has been adopted in achieving paperless office, but none has been able to implement remote access to organizational resources anytime, anywhere which is the main focus of this research paper utilizing mobile computing.

Overview of Mobile Computing and Paperless office

Mobile Computing

Mobile computing is an "architectural framework" which can only be comprehended by disintegrating the architectural framework into its constituent parts. These include portable mobile devices, wireless communication technology and at the central point a server, information system or a database. Mobile computing systems are computational devices that may be easily moved physically and whose computing capabilities may be harnessed while on the move (Reza, 2005). Examples of these devices include laptops, Personal Digital Assistant (PDAs), Smart mobile-phone, Pocket size Personal Computer (PC), calculators, blackberry and ipad.

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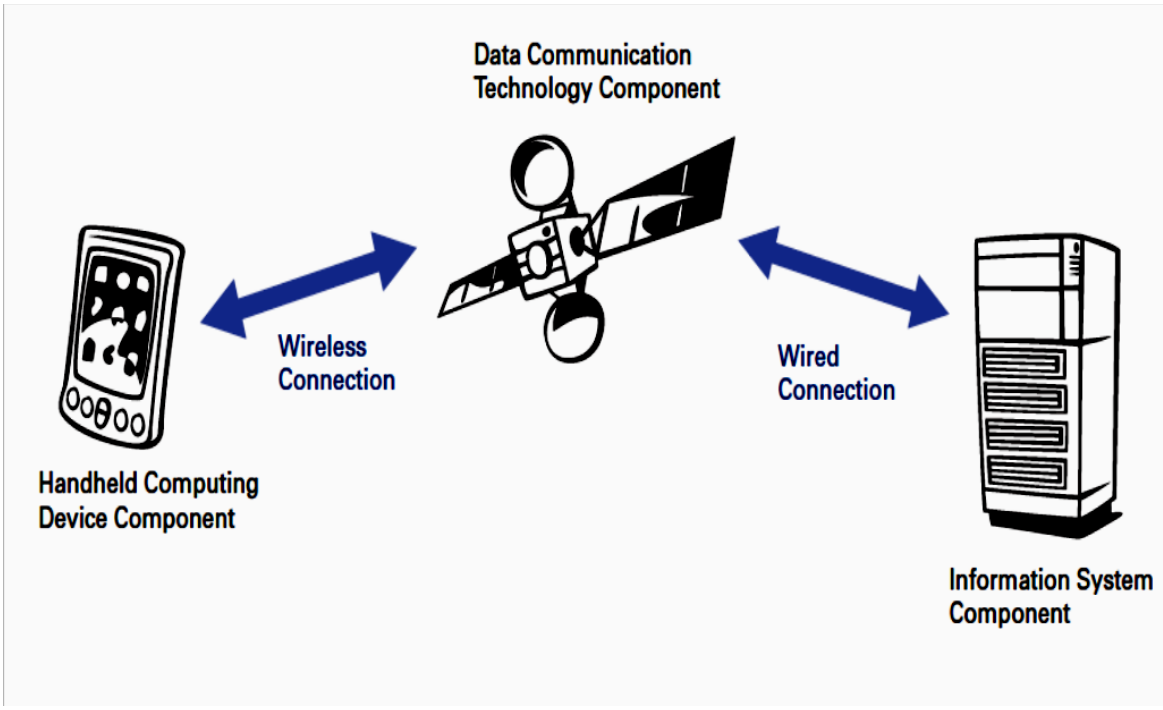

Fig: 3.1 *Architectural Frameworks for Mobile Computing, Fran and Joanna (2001)*

According to Zimmerman, (2009) and Ghosh,(2005), Mobile computing can therefore be defined as the process of utilizing small portable devices and wireless communication technology to achieved computational processes. It is the use of any computer not physically connected by wires to the host or server. It uses wireless interaction, real-time connection and synchronization procedures, depending on the application used. Figure 3.1 pictorially shows the architectural framework for mobile computing. Remote access and remote computing are the backbones of mobile computing which give its edges over other computing paradigms as grid computing, utility computing, automatic computing and soft-computing.

Remote access and remote computing are potency of mobile computing systems which give these devices advantageous edge over stationery computing systems. The synergy of wireless connecting technologies and portable mobile device craftily attuned to provide remote access and processing to stationery-computational resources. These added functionalities are some of the reasons for a separate taxonomy of mobile computing systems. Among the distinguishing aspects of mobile computing systems are their prevalent wireless network connectivity, their small size, the mobile nature of their use, their power sources, and their functionalities that are particularly suited to the mobile user. It is because of these features, that mobile computing applications are inherently different from applications written for use on stationary computing systems. Wireless connectivity, also known as wireless broadband or Digital Data Transmission Technology (DDTT) are the infrastructures and equipment utilized by Internet

Service providers (ISP) to grant wireless Internet access to mobile user on their mobile devices while on the move. These technologies includes

a. **Microwave Links:** Microwave links the traditional point to point light of sight (LOS) wireless transmission of up to 155Mbps with a range of about 5km. It is relatively cheap and easy to install. The greatest disadvantage of microwave link is that it is limited by very low data rate and are therefore of little use for high capacity links or for network where it is essential to ensure that bandwidth capability is never out-stripped by consumer bandwidth demand.

b. **Multichannel Multipoint Distributed Service (MMDS):** Multichannel multipoint Distributed services utilizes a sector antenna in the transmitting base section which send signals to multiple, location within 600 or 900 angle sector. Figure 3.2 depict MMDS (corning, 2005)which provides a transmission rate between 2.1 to 2.7 GHz and can span up to 100km. MMDS can run on licensed and unlicensed bands.

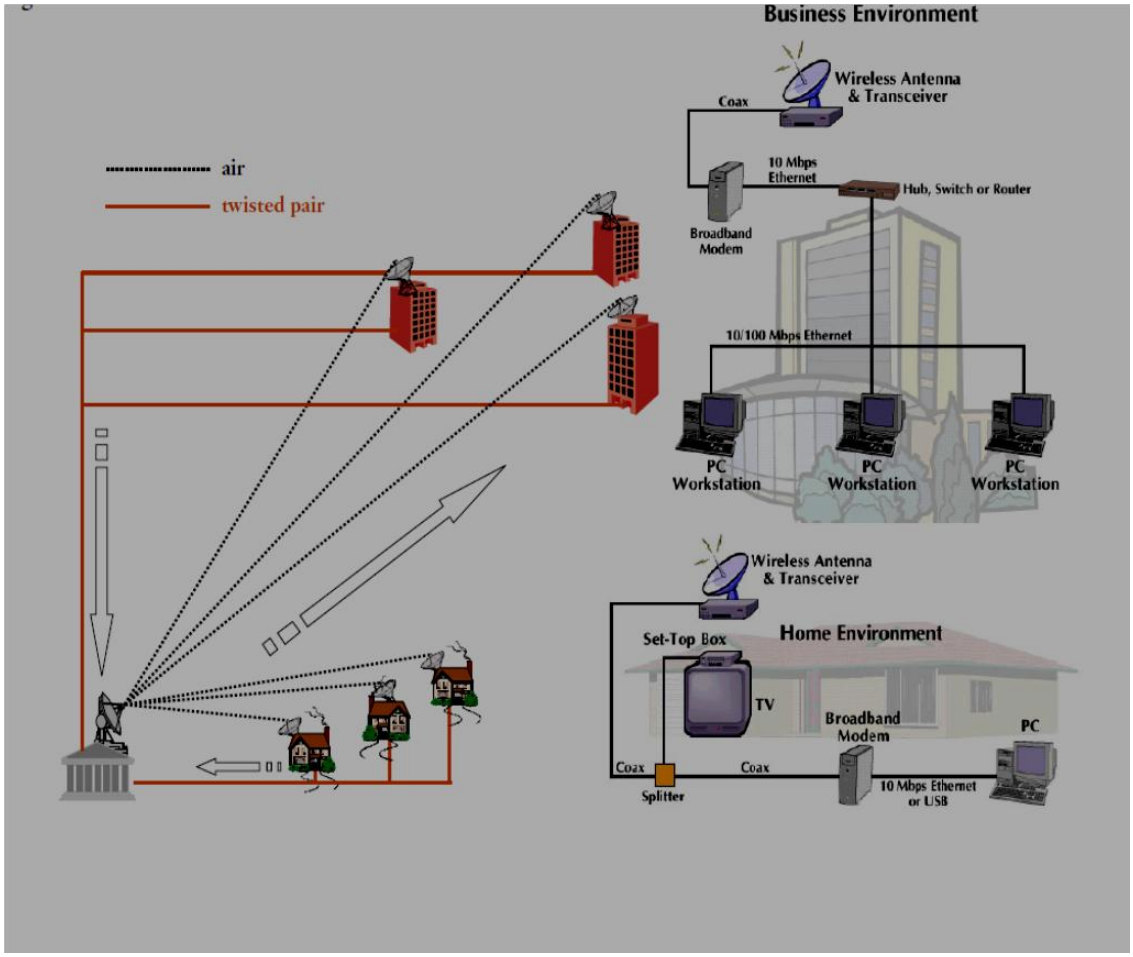

Fig 3.2: *Multichannel Multipoint Distribution Service, Corning (2005)*

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c. **Local Multipoint Distributed Service (LMDS):** LMDS is closely linked to MMDS; it uses a sector antenna at the base station to transmit in a point to multipoint fashion. LMDS commonly operates on microwave frequencies across the 26 GHz and 29 GHz bands and can cover approximately 8km due to higher attenuation. LMDS is drastic limited and the ultimate subscriber capacity and their respective maximum data rate are also limited by the available radio spectrum (radio spectrum is subsidiary of electromagnetic frequencies that is, frequencies lower than around 300 GHz or wavelengths longer than about 1 mm). LMDS is shown in Fig.3.3 (Corning, 2005).

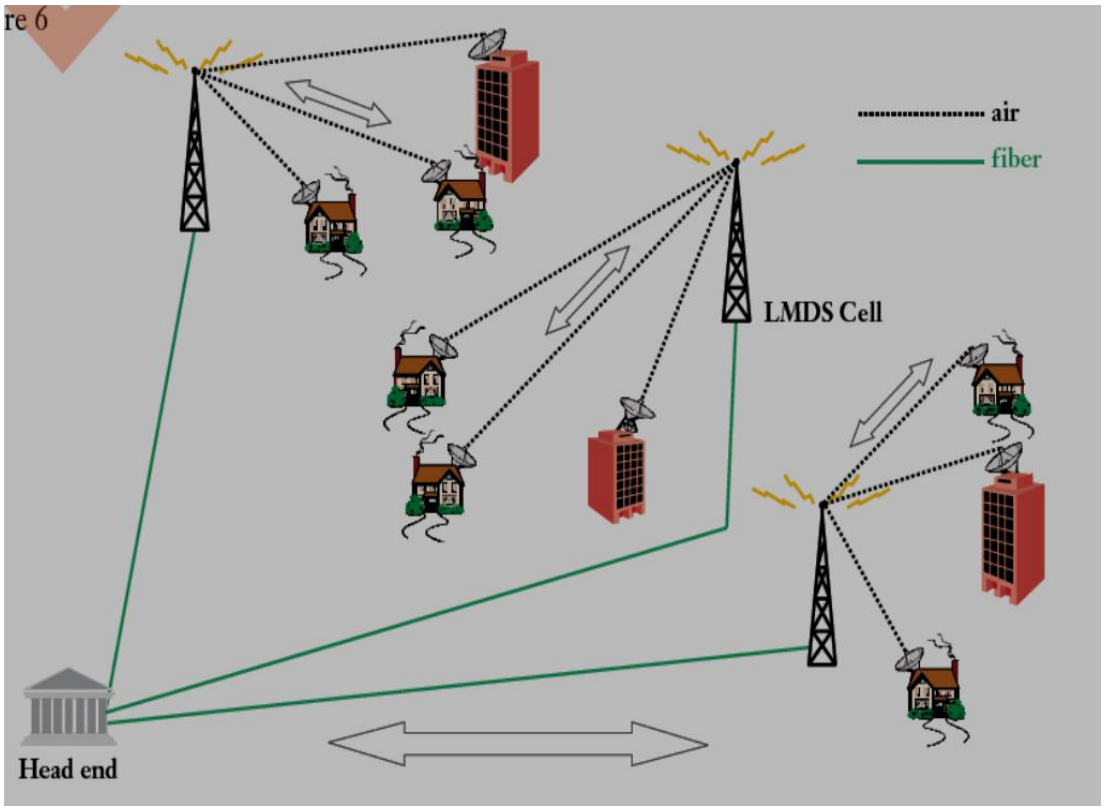

Fig 3.3: *Local Multipoint Distribution Service, Corning (2005)*

d. **Free space Optics (FSO):** Free space optics employs the use of infra-red source or laser to support free-space data transmission between 10mbps and 1.25Gbps and can cover a distance of about 4km. The main advantage of FSO are low installation costs and avoidance of radio spectrum licensing requirement as FSO system use a light signal instead of radio waves. However, due to the point-to-point nature FSO systems are not cost-effective for wide area coverage. They are susceptible to system outage in poor weather condition.

e. **Wireless Fidelity (WI-FI):** Wi-Fi does not require light of light. It is based on IEEE 802.11x standard and transmits in unlicensed spectrum at 2.4GHz. The penetration of signal of these frequencies can go up to 450meters outdoor.
f. **Worldwide Interoperability for Microwave Access (Wimax):** Wimax broadband technology is designed to deliver Wireless Fidelity (Wi-Fi) type connectivity over a much greater range and thereby compete as a point-to-multipoint last mile broadband wireless access solution. There are two types Wimax: Line of Sight (LOS) and Non-line of sight (NLSO). The Los Wimax systems are point to point operation only while the NLOS are point to multipoint.
g. **Direct Broadcast Satellite (DBS):** Direct broadcast Satellite (DBS) services also provide two-way high-speed data transmission services. DBS uses geostationary satellite operating in the K_u band (utilized for satellite communications, most notably for fixed and broadcast services, and for specific applications) with a 12GHz downlink and a 14GHz uplink.

Of all the wireless broadband technologies mentioned, it is difficult to ascertain for a certainty the best of all. They all complement each other. Probably there will be no single technology that will dominate the world of wireless communications. We can expect to have coexisting and overlapping technologies that will create a wireless high-speed communication infrastructure to Internet access worldwide, where each technology is important in a given segment.

Paperless Office

Paper has played a vital role in achieving humans numerously endeavor including the development

of currency of exchange. "Paperless office or paperless environment" could be defined as a virtual working environment. *Paperless office* refers to a working environment where the creation, modification, storage and retrieval of documents (electronic, graphical and virtual) happen electronically. It supports the business processes-oriented management of documents. It entails a move from paper to electronic medium where employees work with electronic documents, e-forms, and documents distributed via e-workflow and e-distribution. According to Hattingh (2009), the aim is to discharge paper documents as the carrier of information and work only with electronic documents. Alternative terms for the paperless office are paper-free or digital office. A paperless office uses less physical space when bulky filing cabinets are eliminated or reduced. Relocating to a smaller office or building may be possible, saving money on a lease. In a paperless office, electronic faxes and email replace the need to print mail and ship documents to clients, which reduces expenses, as does lowering your investment in reams of paper. The chances of losing important documents are lower when scanned and filed electronically, and the documents are often easier to find in an electronic system. Processing documents electronically opens up the opportunity for employees to work remotely and for you to offer flexible work schedules, particularly if you employ remote access to the company system. This can improve efficiency and employee morale.

Paperless office (environment) essentially means drastically decreasing the use and consumption of papers within the office space and not totally

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eliminating it, thereby improving productivity and reducing waste, Joseph (2011).

There are three main approaches in achieving paperless office, Hattingh (2009)

Systemic Approach: Any system that fully automates a process and displaces the paper originally utilized, fostered paperless functionalities for a specific process. To remain fully paperless, and then eliminate the need to print documents that is output.

a. **Forms Platform Approach:** When the process requires print-perfect documents (even if you are not going to print them) the best method for automating forms is to use a platform technology that integrates the data to and from your system with the forms in use. This approach is effective and easy to maintain with multiple documents automation.
b. **Forms Programming Approach:** A single automated form can be implemented utilizing form-level program which will by fostering intelligent and fully-integrated with the system. This approach is the most costly to build and maintain if multiple forms must be integrated with your system.

METHODOLOGY AND DESIGN

The limitations and methods in implementing paperless office remotely foster proposing an Enterprise Paperless Architectural Framework. In disentangling this framework into its varied constituent parts we utilized Unified Modeling Language (UML) design approach with the aim of visualizing the architectural view of the system. This research paper focuses on user, structural and behavior views for modeling the proposed framework.

Proposed Enterprise Paperless Architectural Framework (PEPAF)

A firm foundation for a comprehensive organization paperless framework should provide the organization with an interactive and integrated solution for managing the entire organization life--cycle framework of varied contents including data, information, documents, forms, images, email and more. Empowerment of an organization through paperless environment deals largely with knowledge acquisition, skill, desire and opportunity to personally succeed in a way that engenders collective organization success. Achievement of paperless environment requires executive overall support, standardization and consistency across initiatives and at the same time, has the resources and flexibility to drive this organization-wide change through motivation and persuasion at all levels.

The proposed architectural framework depicted in Fig. 3.4 is an extension of mobile computing architectural framework of Fig. 3.1, due to the added functionalities of classifying organizational resources (critical and non-critical) and granted access to critical resources based on Need to know /list Privilege.

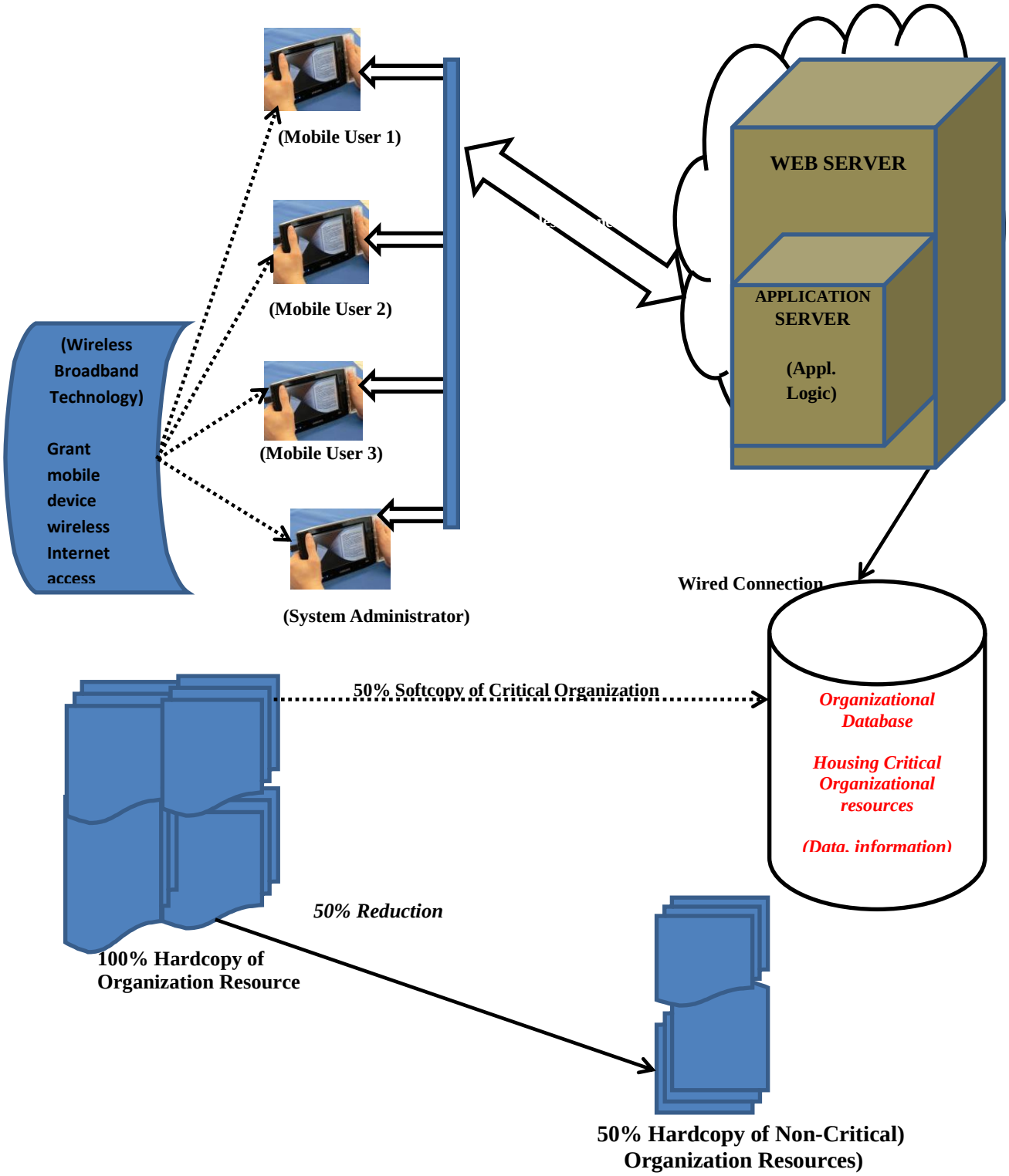

Fig 3.4: Proposed Enterprise Paperless Architectural Framework (PEPAF)

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The Proposed Enterprise Paperless Architectural Framework (PEPAF) must be available in any organization for paperless environment/office to hold sway. The PEPAF has the following illustrative functionalities:

a. **Organizational Database:** The top-level management must sub-divide the organization resources (data and information) into critical and non-critical residing in the database.

***Critical Resources*:** Critical resources are data and information which must be kept confidential and prevented from unauthorized access. These resources usually have high cost of compromise in which case tolerance to compromise is very low. Resources are accessed on a need-to-know basis (segregation of duties). Authorization is delegated to the degree that it relates to the particular level of responsibility of the authorized individual in the organization. These resources should not be tied to organizational boundaries, hence remote access is fundamental.

Non-Critical Resources: Non-critical organizational resources are data and information which are not kept confidential. They are accessed by anyone within the organization. These resources usually have no compromise and tolerance cost and is usually organization-bound.
The PEPAF focuses on the critical organization resources, which are stored in the organizational database in softcopy (electronic forms) and accessed through the organization server.

b. **The system administrator** (Sysadmin) has ultimate privilege to maintain the server and database which involves granting access to relevant organizational resources to end-user base on ***Need to know* /*list Privilege*** and ensuring relevant security checks in place to mitigate (eliminate) unauthorized access.

c. **Mobile-users (clients)** are provided with mobile device with wireless Internet access and vertical (customized) application running in the device. Customized applications are organization-specific and transaction-oriented and normally interfaced with corporate server and database. The mobile user has the right to access and response to relevant update on their mobile device from executive management through the system administration. A user agent, commonly a Web browser, Web crawler and Web navigating application initiates communication by making a request for specific resources using Hypertext Transfer Protocol (HTTP) and the Web server respond with the content of those resources or an error messages if unable to do so.

d. **Middleware services** which enable two or more heterogeneous system to communicate and share resources (data and information) thereby minimizing the need of integration. Middleware is software that serves to glue together or mediate between two separate and often already existing programs. The software resides between a customized mobile application and the network which manages the Graphical User Interface (GUI) on the front-end and Web server on the back-end. The middleware facilitates the client-server connection over the network and allows customize mobile application to access and update remote database and mainframe file. The middleware in our architecture provides the following services.

Transaction processing (TP) Monitoring which handle and monitor database transactions, and are used primarily for load balancing

Remote procedure call (RPC) is a protocol that enables a program, on the client computer to execute another program on a remote computer (usually a server)

Messaging servers which asynchronously prioritize, queue and / or process messages using a dedicated server

e. **Web server** can refer to either the hardware (the computer) or the software (the computer application) that helps to deliver Web content that can be accessed through the Internet. The primary function of a Web server in our framework is to deliver web pages on request to clients (mobile user) using the Hypertext Transfer Protocol (HTTP). This means delivery of HTML documents and any additional content that may be included by a document, such as images, style sheets and scripts.

f. **The application server** which runs inside our Web server provides software applications with services such as security, data services, transaction support, load balancing, and management of large distributed systems. Data and code integrity are also assured by centralizing business logic on an individual server or on a small number of server machines, updates and upgrades to the application for all users can be guaranteed.

Unified Modeling Language (UML)

Unified modeling language was utilized for specifying our design. Unified Modeling Language (UML) is a standard modeling language used for modeling software systems. It provides a number of graphical tools that can be used to visualize a system from different viewpoints. The multiple views (user, structural, behaviour, implementation and environment) of the system that is represented by using diagrams together depict the model of the system (Philippe, 2000 and Chris, 2000). The views typically used are The *User view;* represents the goals and objective of the system from user's viewpoint. The *structured view;* represent the static or idle state of the system. The *behavioural view;* represents the dynamic or changing state of the state. The *implementation view;* represents the distribution of the logical elements, such that as source code structure, runtime implementation structure of the system. The *environment view;* represents the distribution of the physical elements of the system.

This research paper focuses on user, structural and behavior view for modeling the proposed architecture which are clearly depicted respectively in Figure 3.5, 3.6 and 3.7.

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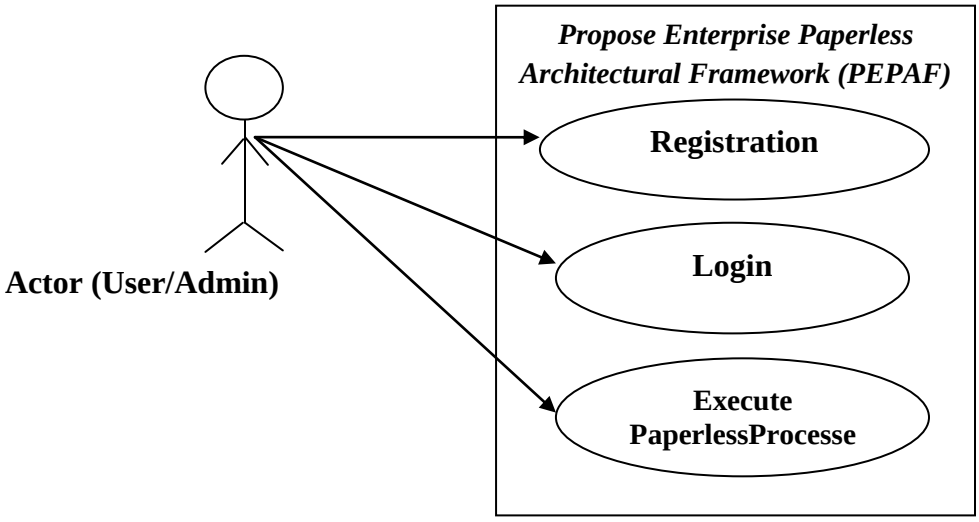

Fig 3.5: *Use Case Diagram modeling PEPAF*

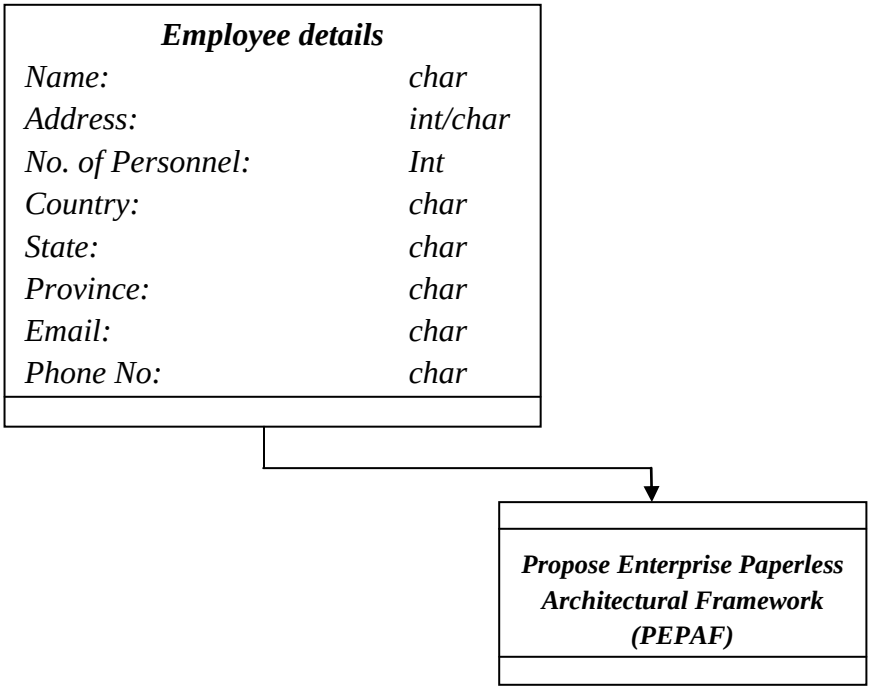

Fig 3.6: *Class diagram Showing Attributes, generation and composition Association for PEPAF*

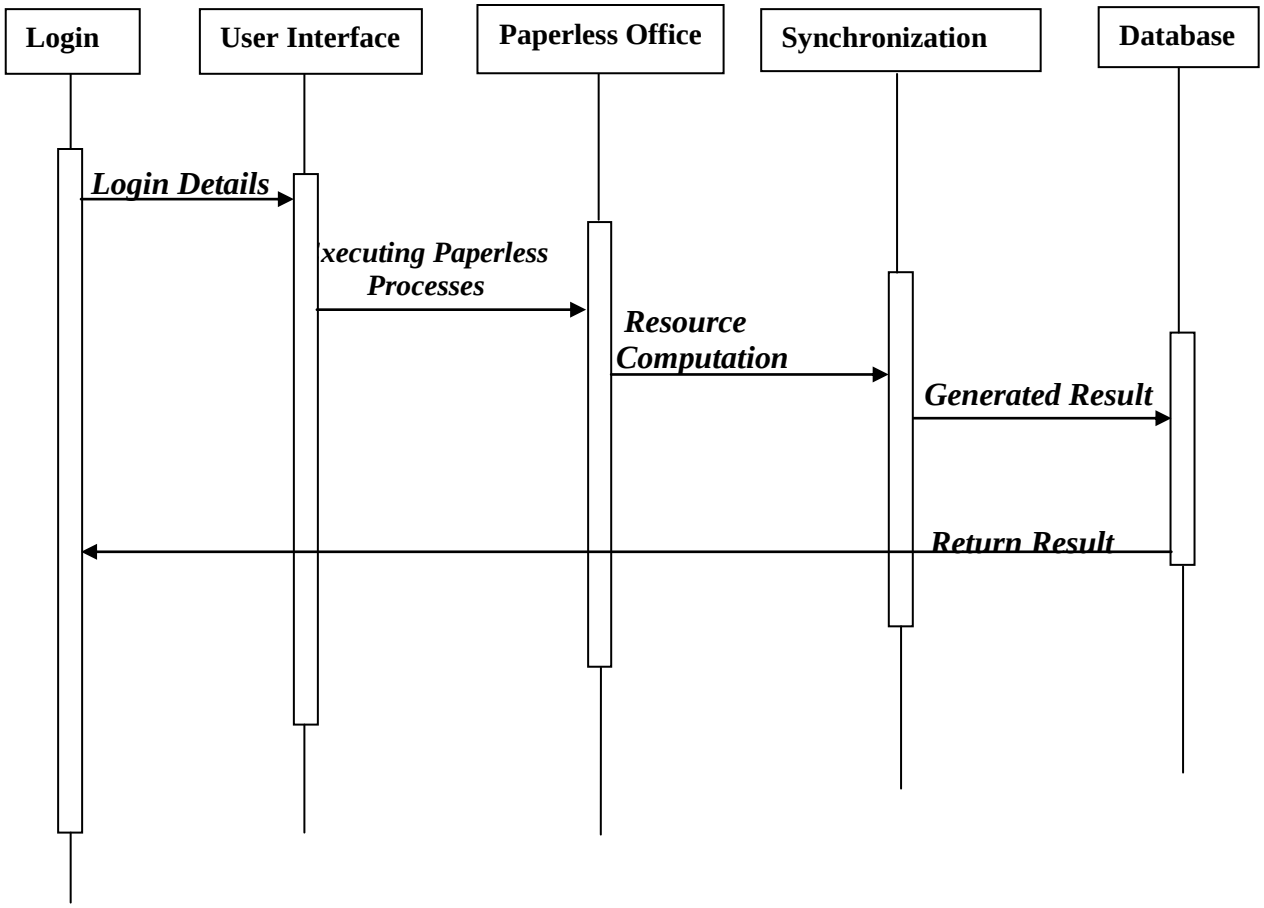

Fig 3.7: *Sequence Diagram modeling PEPAF Processes*

DISCUSSION

The proposed Enterprise Architectural framework provides a centralized repository where all critical organizational documents are accessed and managed, through the system administrator granting access to employees based on their job description and level of expertise thereby eliminating the inefficiencies of having critical documents scattered across file cabinets, shared drives and local hard drives and accessed by any employee. Its rich features are customized with each deployment, allowing it to work in parallel with companies' existing workflows, processes and culture. The Proposed architectural model is cost-effective and harnesses relevant organization resources.

CONCLUSION

The evolution of wireless mobile devices and the overall integration of these devices with wireless broadband technologies, server, and a central repository (database) have given rise to mobile computing as a fundamental approach in augmenting paperless office. The architectural framework propose in this research paper is a synergy of this varied components in other to achieve paperless environment. This architectural framework on full implementation will reduce drastically the consumption of paper documents within an organization by 50%, extend IT capabilities (resources) and provide an avenue where these IT capabilities can be harnessed

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anytime and anywhere. This research has provided an essential knowledge into the underlying of mobile computing, paperless office and a proposed architectural framework for achieving paperless office within an organization while exploring its benefits across varied boundaries. Prospective users are now aware of the range of critical solutions offered by mobile computing paradigm, the application executing both on the mobile device and synchronizing at the central repository (database) situated at the organization stationery boundaries.

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